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THE STATUS OF THE SOUTH INDIAN BLACK LEAF-MONKEY (*PRESBYTIS JOHNII*) IN THE PALNI HILLS[1]

J. F. Oates[2]

(*With a text-figure*)

Short surveys were conducted in 1976 in the Palni Hills, Western Ghats, to assess the status of the black leaf-monkey *Presbytis johnii* (the "Nilgiri langur") and its forest habitat. Evergreen forest was found to be patchily distributed in the hills and only some of the patches contained leaf-monkeys. I estimate that between only 150 and 500 leaf-monkeys survive in the Palnis, mostly on the south western escarpment. The leaf-monkey population is under pressure from man through habitat destruction and hunting. Action is recommended to alleviate these threats.

Introduction

The Nilgiri langur or S. Indian black leaf-monkey[3] is listed as "vulnerable" in the I.U.C.N. Red Data Book (Goodwin & Holloway 1972). But accurate information on the status of the species throughout its range is not available. A recent report on its status by Kurup (1975) covered in detail only parts of the area from which it has been recorded

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[3] I prefer this term to the commonly-used "Nilgiri langur" since the species occurs in many hill areas in addition to the Nilgiris and is known locally as "black monkey" rather than "langur". "Langur" is a Hindi word which applies specifically to *Presbytis entellus*. "Leaf-monkey" is frequently used with reference to the Southeast Asian members of the genus *Presbytis*.

(distribution data are summarized by Daniel & Kannan [1967] and Oates in press). To fill some of the gaps in information on the species' present abundance, and to complement an intensive ecological study being undertaken at one locality in Tirunelveli District, I have made surveys in two hill ranges (Palni and Ashambu) not treated in the reports of Krishnan (1971) and Kurup (1975). This report covers the Palni Hills.

Natural history of *Presbytis johnii*

Apart from light reddish-brown hair on the head and (in females) white thigh patches, *Presbytis johnii* has an entirely black coat. It is characteristically an inhabitant of evergreen forest, including relatively thin strips of riverine gallery forest bordered by other vegetation types. It is herbivorous and its diet includes large quantities of tree leaves. Black leaf-monkeys typically live in social groups, often of 10-20 animals, with a single adult male. The adult male has a characteristic loud whooping call, which is frequently produced at or soon after dawn (Tanaka 1965; Poirier 1969, 1970a, 1970b; Horwich 1972; personal observation).

Although black leaf-monkeys probably always base their activities in evergreen forest, they do occasionally enter other habitats. McCann (1933) says that they may frequently be seen crossing open stretches of grass between *sholas* (evergreen forest in valleys) and notes the monkeys sunning in the topmost branches of tall, planted *Eucalyptus* trees near *sholas*. Prater (1971) notes that they may invade gardens and belts of cultivated woodland. In the Ashambu Hills they occur at very low elevations in river valleys (down to approx. 108 m alt.) and may also be seen feeding in open deciduous woodland some way from the riverine forest (personal observation). In the Nilgiri and Palni Hills, *Presbytis johnii* is found as high as 2400 m alt. (Poirier 1970a; M.A.R. Khan personal communication; this report, below).

Description of the Palni Hills

The Palnis (or Pulneys) are the north-eastern spur of that section of the Western Ghat mountains which stretches from the Ariankavu Pass (9°00′N) to the Palghat Gap (10°35′N). They extend east-north-east for some 65 km from the valley of the upper Ten Ar River at approx. 77°15′E* to 77°50′E, just west of the town of Dindigul. If their foot is taken as the 500 m contour, their width varies between 20 and 40 km (between latitudes 10°01′N and 10°27′N) (see Fig. 1). The hills rise by steep escarpments to a high, undulating plateau, much of which is above 2000 m and whose highest point is Vembadi Shola peak (2508 m; 8221 ft).

Climate varies over the range, but much of the plateau receives an average of more than 1200 mm of rainfall annually with no more than four dry months. The southern face of the hills is wetter than the northern. In the higher areas mean temperatures in the coolest month are below 15°C. At the main town on the plateau, the hill station of Kodaikanal (10°14′N, 77°29′E; 2343 m alt.), temperature varies between a mean monthly minimum of 8.1°C and a mean monthly maximum of 18.5°C. Blasco (1971) gives details of the Palni climate.

Over much of the Palni plateau the "natural" vegetation is a short-grass montane savanna, often dotted with small trees of *Rhododendron arboreum* var. *nilagarica*. The various

* Taken by Kurup (1975) as the eastern boundary of the Anaimalai Hills in his survey.

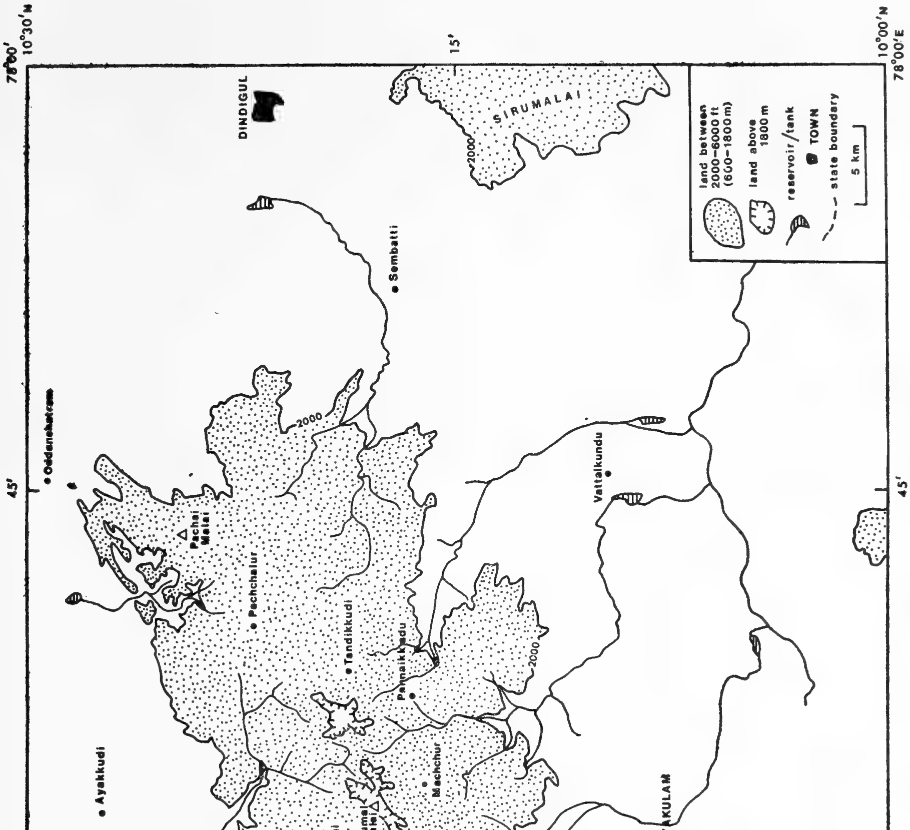

Fig. 1. Map of the Palni Hills, showing localities mentioned in the text.

savanna formations are described by Blasco (1971), who believes that savannas in these areas result primarily from the influence of fire, presumably generated by human hunters and graziers. The plateau forests are thus largely restricted to sheltered ("encaissées") valleys on well-drained soils. The "savannization" of the S. Indian high plateaux is provisionally dated by Blasco to within the last 3000 years. Burning still occurs in the grasslands today.

Since the opening-up of the Palni Hills from the latter part of the 19th century, large areas of the plateau have been planted with gum (*Eucalyptus* spp.) and wattle (*Acacia* spp.). Today many of the remaining tracts of savanna are being ploughed initially for potato cultivation, but with young trees, especially pines, being planted amongst the potatoes to supersede the vegetable crop.

The surviving evergreen forests of the upper elevations of the Palnis are divided by Blasco into *ridge forests* ("forêts de crêtes") and, in valleys, *sholas*. Both types survive only in small patches on the plateau, and ridge forests are particularly scarce. Although forest disappearance seems to have been a long-term process, in action for thousands of years, a certain amount of shola has been felled within recent times—Blasco notes the destruction of Bear Shola near Kodaikanal between 1963 and 1970 and the felling since 1969 of 400 hectares of shola covering the upper basin of the Ten Ar River. However, present Forest Department policy seems to be to protect, at least nominally, what little evergreen plateau forest that remains.

Shola forests also occur on the upper escarpments of the Palnis, and are an abundant vegetation type in precipitous valleys on the wet southwestern face of the hills. Evergreen forest apparently once extended down these valleys almost to the plains. The natural vegetation of the southern and eastern slopes of the Palnis, apart from the sholas of the wet valleys, is semi-deciduous forest, and on the northern slopes dry deciduous forest. Below about 900 m the forest becomes scrubby. It was evident from my survey that parts of the northern slopes are heavily grazed by cattle, and that up to around 1300 m the eastern slopes carry extensive plantations, particularly of coffee, bananas and silk-cotton trees. The encroachment of the Palni vegetation by Kumari potato cultivation on the plateau and by plantations at the foot of the hills is also described by Davidar (1975).

The survey

Methods:

The Palni Hills were visited from 4-10 June and 28-29 July 1976. The survey consisted of three main parts: (a) driving through the range by Jeep, noting the status of the vegetation and questioning people by the road and at settlements on their knowledge of black leaf-monkeys (this was done mainly through a Tamil-speaking field assistant, Mr. D. Michael); (b) interviewing individuals with a knowledge of the vegetation and fauna of large parts of the range (i.e. officers of the Tamil Nadu Forest Department and H. H. the Raja of Pudukkottai in Kodaikanal); and (c) visiting areas of forest which reports suggested to be particularly promising as leaf-monkey habitats—I walked through these forests, noting details of the flora and fauna and searching for monkeys. I also listened for their unmistakable loud calls (particularly at dawn).

The route taken on the June survey was the main ghat road ("Law's Ghat") from Vattalkundu to Kodaikanal, from Kodaikanal east

on the Cochin road to Berijam (10°11′N, 77°24′E) and then on as far as Mariyanshola (10°09′N, 77°21′E), from Mariyanshola back to Berijam and then north *via* Mannavanur to Kukkal (10°17′N, 77°22′E), from Kukkal via Pumbarai and Gundar (10°13′N, 77°26′E) to Kodaikanal, from Kodaikanal *via* Pannaikkadu to Tandikkudi (10°18′N, 77°39′E), and from Tandikkudi east to the plains near Sembatti (see Fig. 1). In July the northeastern section of the hills was visited, driving up from the plains at Oddanchatram to Pachchalur (10°22′N, 77°40′E), and from there for a short distance towards Tandikkudi, before returning to the plains by the same route.

Results from general survey and interviews:
This survey, and information obtained at interviews, made it clear that rather little suitable *Presbytis johnii* habitat (evergreen forest in a relatively undisturbed state) survives in the Palnis, as has already been noted in such publications as Spillett (1968) and Blasco (1971).

My observations indicate that the remaining areas of evergreen forest in the Palnis are:

(i) Close to rivers in the valleys along the southern face of the hills to the east of Kodaikanal.

(ii) "Tiger Shola" on a hillside just east of Kodaikanal.

(iii) On the southern edge of the plateau and on the steep southern escarpment from Kodaikanal west to the Kerala border near Top Station.

(iv) In patches on the edge of the plateau near Kukkal.

(v) A patch near Gundar, close to the road between Pumbarai and Kodaikanal.

(iv) At Gunguvar Odai, north of Kodaikanal towards Palni town (reported by H. H. the Raja of Pudukkottai).

(vii) Small patches on the flanks of Perumal Malai peak (2234 m; 10°18′N, 77°34′E).

(viii) In an area called Andialai, 2 km south of Tandikkudi, where the forest is underplanted with cardamom.

(ix) Small patches around Pachchalur, some underplanted with cardamom.

(x) Close to the summit of Pachai Malai (1299 m; 10°24′N, 77°43′E); this very small area of forest was observed only from lower on the hill (where the vegetation was dry woodland) and its exact character was not determined.

Areas (iii), (iv) (v) and (x) were examined on foot and are described in detail in the next section. Interviews suggested that the status of black leaf-monkeys in the other areas (in which the canopy was in most cases scanned with binoculars) is as follows:

(i) Leaf-monkeys seem to be almost entirely absent from the southeastern valleys, but 2 men reported that they occur below Machur on the road between the settlements of Oothu and Perumalmalai, in the valley of the "Thalasiar" river. The valley vegetation there is below 1000 m altitude. Bonnet macaques (*Macaca radiata*) were reported from forests near the road and one group was seen at an altitude of about 1300 m.

(ii) No leaf-monkeys occur in Tiger Shola (Forest Department and H.H. the Raja of Pudukkottai).

(iii) H.H. the Raja of Pudukkottai reports that a few *P. johnii* occur at Gunguvar Odai, but that they are very difficult to find. This is probably at the headwaters of the Thevankariar River.

(iv) A few leaf-monkeys may survive in the sholas on Perumal Malai. Some people said they were or might have been found there, others said there were none.

(v) Careful questioning of several people

who had lived at Tandikkuddi all their lives, or who worked in or near the cardamom estate, produced the response that there are no leaf-monkeys in the Andialai forest. However, *M. radiata* was said to be present, and one group of this species was seen by the road between Tandikkuddi and Pannaikkadu at an altitude of 1300 m.

(vi) It is probable that no leaf-monkeys exist today near Pachchalur (about 1250 m alt.). Many people here were questioned. Several said that black monkeys were found at Champrankulam, between Pachchalur and Ayakkudi, but when closely interrogated on the monkeys' appearance it seemed clear that they were referring to *Presbytis entellus* and that they had in mind its black *face*. This is a caution that the mere statement of the presence of "black monkey" is unreliable evidence. Otherwise, everyone questioned said that no black monkeys existed near Pachchalur. One elderly man who had lived there all his life, who hunted in the forests and knew them well, was adamant on this point. However, E. Ugarte, S.J. (personal communication) recalls that he may have heard the call of *P. johnii* in the Pachchalur area around the year 1960.

Results from investigation of particular forests

Southern escarpment

From near Kodaikanal west to the Kerala border near Top Station (a distance of about 25 m) most of the valleys running down the scarp face, and a few of the ridges, carry evergreen forest. The upper edge of the scarp lies at between 2000 and 2500 m, and the face drops away within a horizontal distance of some 2 km to an altitude of only 1000 m, where there is semi-deciduous forest. Between the patches of evergreen forest are open rock (often as near-perpendicular cliffs) and grassland. At one time, all these forest patches would have probably been connected by evergreen forest at a lower altitude where the valleys meet. But today the low-altitude vegetation is much disturbed by man.

One of the most extensive patches of scarp forest is the Mathikettan shola on the edge of the escarpment near Berijam. This reaches downhill from about 2200 m altitude, and was investigated on foot on 5 June 1976 between 0944 and 1645 h. The area of continuous forest here was assessed to be at least 2 km^2 and perhaps more than 3 km^2. The largest trees in the area investigated were estimated to reach a height of 25m, with their crowns only occasionally in contact. Most of the large trees were identified as *Syzygium* sp. (possibly *S. arnottianum*) and *Cinnamomum wightii*, with a few *Elaeocarpus recurvatus*. *Actephila excelsa* was numerous in the middle tree-layer, and in the understory *Lasianthus* sp. was abundant. On parts of the forest floor were many *Calanthe veratrifolia* orchids. The woody vine *Toddalia asiatica* was common. A somewhat similar ridge forest in the Berijam basin is described in detail by Blasco (1971). [Plant identifications reported in this paper were made in the field by reference to Gamble & Fischer (1967) and Blasco (1971); they have not been confirmed by a botanist.]

In this forest animals belonging to one group of *P. johnii* were clearly seen and it was estimated that the group contained at least 10 animals. A second group of monkeys was heard but not clearly seen. The loud whooping call of an adult male *P. johnii* was heard across a valley to the southwest of the section of forest investigated on foot.

Several Malabar squirrels (*Ratufa indica*) were seen or heard in Mathikettan shola, and tracks and droppings probably belonging to gaur (*Bos gaurus*) were noted. A group of at least 13 *Macaca radiata* was seen to run

out of a wattle plantation at 2200 m adjacent to the forest and climb down the steep open cliffs of the escarpment.

On 6 June the scarp forest near Mariyanshola rest house was examined between 0905 and 1125 h. One shola of under 1 km^2 occupying a small valley was traversed on foot. It extended downhill from about 2300 m. The shola contained many *Cinnamomum wightii*. *Syzygium ? arnottianum* was also noted, and *Calanthe veratrifolia* was again abundant in patches. A common vine was tentatively identified as *Derris brevipes*. A group of *Macaca radiata* was sighted in this shola and the chirruping calls of Malabar squirrels were heard. A large animal, probably a sambar (*Cervus unicolor*), ran off on the forest floor without being seen. No leaf-monkeys were seen or heard in this forest, but a whooping call was heard from another belt of shola to the west, along the scarp towards "Land-Slip Hill". From "Pass Peak" (2390 m) two bouts of *P. johnii* whooping were heard from forest to the east of Mariyanshola (but west of Mathikettan).

Therefore sightings and calls gave definite evidence of 4 - 5 distinct *P. johnii* adult males, each probably accompanying a group, on the scarp between Berijam and Land-Slip Hill (a distance of approximately 10 km). It is possible that at least twice this number of groups was actually present.

There is also forest on the scarp to the east of Berijam, towards Kodaikanal. *P. johnii* occurs in this forest, as evidenced by a whooping bout heard below Pillar Rocks only about 6 km from Kodaikanal. Although the scarp west of Land-Slip Hill (77°20′E) was not examined, leaf-monkeys almost certainly occur between there and Top Station. H. H. the Raja of Pudukkottai reports their occurrence near Vandaravu on the road to Top Station.

The isolated groups in the scattered sholas of this southwestern escarpment are certainly in vocal contact with each other and occasional physical contact probably occurs by means of terrestrial movement across the open ground between sholas. Such movement might be expected particularly from solitary large males without "their own" groups.

Kukkal

One relatively large patch of evergreen forest survives on the northwest edge of the Palni plateau west of the settlement of Kukkal. Over 50 years ago McCann collected a specimen of *P. johnii* at Kukkal (McCann 1933) and Forest Department officials in Kodaikanal reported to me the monkey's presence there.

I visited Kukkal from the evening of 6 June to the morning of 8 June, and the Kukkal Forest was explored on foot from 0725 to 1546 h on 7 June. The forest is described by Blasco (1971). It lies on the flanks and crest of a north-south ridge and is mostly between 1950 and 2100 m alt. Some tongues of forest reach to a lower altitude, especially to the west of the ridge where small valleys run down into the broad Ten Ar valley. On the east, drainage is into the Kudiraiyar River valley, which runs north off the plateau. The Kukkal Forest is roughly rectangular, extending approximately 4 km north-south and 2.5 km east-west, but there are extensive grassland intrusions into the rectangle. There are a few small patches of shola near Kukkal village but there is no other extensive area of evergreen forest in the vicinity. The climate of the northwestern sector of the Palnis is, in general, drier than that of the southern escarpment.

My survey route through the Kukkal Forest followed existing paths west on to the ridge and then north, emerging on a grassy hill with a small temple at its summit (Papalai, alt.

2200 m). From here one could see most of the forest, and there was a fine view west towards Manjampatti in the Ten Ar valley, with the Anaimalai range rising behind. From this point near the north end of the forest I walked approximately south along the ridge through the length of the forest, emerging on another hill at the southern end. I then skirted the southeast of the forest, reentered it and travelled northeast back to Kukkal.

There was considerable variation in the vegetation between different parts of the forest. Near Kukkal, in the northeast quadrant of the forest, most of the large trees were identified as *Cinnamomum wightii, Beilschmiedia wightii, Pouteria tomentosa, Litsaea wightiana* and *Elaeocarpus oblongus*. These trees were mostly estimated to reach no more than 20 m in height, but occasional specimens of *Cinnamomum* were estimated to reach 30 m. In many places their crowns were not in contact and a thick layer of large herbs and shrubs covered the forest floor. The forest had a moist appearance in this area and land leeches were abundant. The more southerly parts of the forest examined seemed drier. Here there was a closed canopy and the understory was much more open. Amongst large trees *Cinnamomum wightii* was again common, but *Syzygium ? arnottianum* was also noted to be particularly abundant. A common small tree was tentatively identified as *Daphniphyllum neilgherrense*. On parts of the ridge crest there was a very stunted dry woodland.

I saw no black leaf-monkeys in the Kukkal Forest, nor any food remains nor droppings that might be attributed to them. However, the local guide, who seemed reliable, reported having seen black monkeys two months before our visit. Other people questioned at Kukkal said either that there were no black monkeys to be found nearby or that they were rare. One man said that they were found only in the Ten Ar valley. During all the time I was at Kukkal, no black-monkey loud calls were heard, even though my camp had been set within 200-300 m of the forest.

The appearance of the Kukkal Forest suggested that it could support several groups of *Presbytis johnii* and the monkey was certainly present there at one time (as evidenced by McCann's specimen). But if it still survives at all at Kukkal it must be rare, and it may have been hunted to extinction. Although I heard probable gun shots from the direction of the forest on the evening of 7 June, people at Kukkal denied that monkeys are hunted there. This leaf-monkey is hunted in many parts of South India for its fur, meat and the supposed medicinal value of its blood and organs (Poirier 1970a).

Amongst other mammals at Kukkal, droppings and tracks of gaur were much in evidence, the scrapes and pug marks of a leopard (*Panthera pardus*) were seen, as were the droppings of wild dog (*Cuon alpinus*). One group of bonnet macaques was seen at the southeastern edge of the forest, at an altitude of 2150 m (these macaques do not have the commercial value of *P. johnii* and are therefore not subjected to the same hunting pressure). No Malabar squirrels were seen or heard, and there was no evidence of elephants (which had been reported to be abundant at Kukkal by Forest Department officers). Our guide, without any prompting, reported that Nilgiri tahr (*Hemitragus hylocrius*) occurred on cliffs to the northeast of the forest. He said he had seen five "varai aadu" there a few days before my visit. Davidar (1975) reports hearing of four tahr on the Kukkal cliffs. However, there were signs that the grass had been burned not long before my visit, and large herds of cattle (apparently from Manna-

vanur) were being pastured in the grasslands below the Kukkal Forest. This interference, combined with the possibility of unregulated hunting, does not favour the survival of a small, isolated tahr population.

Gundar

Several people reported to me the presence of *P. johnii* at Gundar, which I visited on the morning of 8 June. An investigation of an area of evergreen forest on a hillside close to the southeast of a Forest Department settlement and tree nursery was made on foot between 1000 and 1212 h. No other extensive area of evergreen forest could be seen near Gundar.

The Gundar shola extends south up a hillside from one of the upper branches of the Gundar River, which rises on the eastern flank of Vembadi Shola peak, close to the west of Kodaikanal, and flows north to join the Shenmukha River, a tributary of the Amaravati. It lies at approximately 2100 to 2250 m, occupies an area of about 1.0 to 1.5 km^2 and is surrounded by scrub, plantations of gum and wattle, and newly-cultivated potato fields. The largest shola trees were estimated to reach at least 25 m in height, with *Cinnamomum wightii, Beilschmiedia wightii, Elaeocarpus recurvatus, Syzygium ? arnottianum, Litsaea oleoides, Pouteria tomentosa* and *Elaeocarpus oblongus* present. What was probably *Daphniphyllum neilgherrense* grew in the middle layers of the forest and climbing *Toddalia asiatica* was identified. There was a fairly open understory, containing *Psychotria* sp. and *Lasianthus* sp. in the shrub layer, with *Calanthe veratrifolia* on the forest floor. There were some thick patches of bamboo at the forest edge.

This shola was traversed from east to west close to the river and then from west to east higher up the hillside. No leaf-monkeys were seen or heard. Evidence of at least three Malabar squirrels was obtained from calls and sightings, and several squirrel nests were seen. The tracks and droppings of gaur were seen and there were signs of grubbing by pigs (*Sus scrofa*). The quill of a porcupine (*Hystrix indica*) was found on the forest floor. No land leeches were noticed.

Since people at Gundar were confident that *P. johnii* was present in this shola, and since my search had been short, I returned to Gundar at dawn on 10 June. At 0604 h and at 0707 h *P. johnii* whooping loud calls were heard from two separate sites in the shola. This indicated the presence of at least two adult male leaf-monkeys in the Gundar forest and probably therefore the presence of at least two social groups. No whooping was heard from any other location near Gundar.

Pachai Malai

This hill, visited on 28 and 29 July, was the only locality to the east of Perumal Malai where statements from local people suggested the possible presence of *P. johnii*. Many people at Nellikuli Kadu below the hill were questioned. Several claimed that black monkeys were present near the top of the hill. However, on closer questioning it was apparent that some of these people were referring to *P. entellus* and that most of them had not visited the hilltop but based their reports on hearsay, although a few claimed to have seen the monkeys themselves. A man who hunted in the area said that he had seen one black monkey with a group of bonnet macaques, one farmer described a monkey with a white tail and black body and head, and another described a completely black monkey with a black beard.

Pachai Malai lies in the dry northeastern

sector of the Palni Hills and is isolated from the main plateau. Most of the land surrounding the hill is cultivated. I climbed up to an altitude of about 850 m on the north flank of the hill on the evening of 28 July. The vegetation on the lower part of the hill bordering cultivated land (at about 650 m) is thorny scrub woodland with a very dense shrub layer, much disturbed by man. At 850 m the shrub layer is more open and the trees are larger (some reaching to around 20 m) but their crowns are mostly not in contact. The vegetation is best described as dry deciduous forest (or woodland) and is quite different from typical *P. johnii* habitat. During 1.5 h on the hill before dusk, no leaf-monkeys were seen or heard, but a single group of bonnet macaques was encountered.

A scan of the north face of Pachai Malai from below suggested that evergreen closed-canopy forest exists only in a small area (under 10 hectares) in a river valley near the summit of the hill. The south face of the hill was not examined.

For one hour from dawn on the morning of 29 July I waited on the crest of a low hill northwest of Pachai Malai, about 250 m from the forest edge. No monkey calls were heard.

In my judgment, it is unlikely that any black leaf-monkeys exist on Pachai Malai and I think H.H. the Raja of Pudukkottai is almost certainly correct in his view that none of these animals occurs today east of Perumal Malai. However, the reports made by local people cannot be entirely dismissed, especially as *P. johnii* is known to exploit open woodland at low elevations in the Ashambu Hills.

Conclusions

A few thousand years ago evergreen forests probably covered a major part of the upper Palni Hills, supporting a large population of black leaf-monkeys. Today, such forest remains only in patches and only some of these patches still contain leaf-monkeys. Even 50 years ago the leaf-monkey was quite common in practically all the forests of the range (E. Ugarte, S.J., personal communication), and it was not uncommon in the environs of Kodaikanal town up to the mid-1950s (H.H. the Raja of Pudukkottai quoted in Daniel & Kannan 1967). According to the Raja, the species is still heavily hunted in the Palni Hills, both by local people and by hunters from the plains.

The largest remaining population seems to be on the southwestern escarpment of the hills. The number of leaf-monkeys living here probably falls somewhere between a minimum of 100 and a maximum of 300 individuals. Hunting may not be a significant problem close to Kodaikanal and Berijam, because of the proximity of Forest Department establishments, but it almost certainly occurs on the more remote parts of the scarp. Agricultural encroachment is damaging forest on the lower parts of the scarp. If this continues upwards there could be a serious reduction both in the extent of potential leaf-monkey habitat and in the frequency of contact between groups.

A few leaf-monkey groups survive in other areas, with at least two groups probably in the Gundar valley (which may be protected from hunting by its proximity to a Forest Department establishment and to the Kodaikanal road), but it seems unlikely that more than 15 groups (or perhaps 150-200 animals) survive in all areas other than the southwestern escarpment, and this could well be an overestimate. Tentatively I would therefore suggest a possible minimum of 150 leaf-monkeys in the Palni Hills in 1976 and a maximum (a rather unlikely maximum) of 500.

Although present Forest Department policy

seems to be preserve the patches of evergreen forest that remain in the Palnis, at least on the plateau, I think that the leaf-monkey population could still become extinct if further action is not taken. The following actions are recommended:

(1) Taking stronger measures to prevent the hunting of monkeys (and of other animals). This requires paying more attention to areas, such as Kukkal, that are remote from large Forest Department establishments.

(2) Halting agricultural encroachment on the forests of the lower hill-slopes, particularly the southern escarpment.

(3) Giving special protection from cultivation, grazing and burning to any other vegetation which occupies a narrow gap between existing patches of evergreen forest, so that in the long term the patches will be more effectively linked for their populations of forest animals.

Even if these actions are taken and are effective, they may be too late to save leaf-monkeys from extinction in some isolated forests (e.g. Kukkal) that were once definitely occupied. If the monkeys do not naturally recolonize these forests after several years, consideration might be given to the introduction of animals from elsewhere. This would need great care. It should not involve the capture of wild monkeys unless they are from a population whose own habitat is being irreversibly destroyed. Captive animals confiscated by the Forest Department might be considered for reintroduction, but only where there is little danger of infecting wild animals with any diseases acquired by the captives.

Evergreen forest in the Palni Hills needs protection not just because of its leaf-monkey population but because of the many other interesting species of plants and animals which it supports (and for a summary of important reasons for conserving shola forests in general, *see* Green & Minkowski [1977]). The semi-natural grasslands of the plateau also have great biological interest, but they are being converted rapidly into potato fields and plantations of exotic trees. Overgrazing by domestic livestock affects many parts of the foothills, and illegal hunting is probably widespread throughout the range. Davidar (1975) notes the threat to the Nilgiri tahr population on the southwestern escarpment posed by poaching, potato cultivation and cattle grazing. I understand that there are well advanced plans for bauxite mining in the vicinity of Mariyanshola. Such an operation could cause large-scale habitat disturbance.

If a significant proportion of the natural vegetation and its wild animal inhabitants in the Palnis is to survive, a careful examination must be made of the whole range of exploitationary activities which are in progress or planned to assess how their impact might be mitigated. A detailed survey is required to provide information on the distribution and abundance of populations of all the large animals and to assess the status of the natural vegetation. Serious attention should be given to the idea of the Kodaikanal Hills sanctuary outlined by Spillett (1968). However, a sanctuary should include plateau areas and the southwest escarpment, and not just the deciduous forests up to 3000 ft (900 m) of the original proposal. Properly developed, such a sanctuary could only increase the attractiveness of Kodaikanal as a resort, which the spread of cultivation and the decline of wildlife surely cannot.

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FLORA OF MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU[1]

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(*With a map*)

A floristic account of Mudumalai Wildlife Sanctuary which lies between 11°32′-11°43′ N and 76°22′-76°45′ E in the Nilgiri district of Tamil Nadu is given in this paper. A total of 506 taxa of flowering plants and ferns are reported from the sanctuary. Five species not reported by Gamble & Fischer (1915-1936) in the Flora of the Presidency of Madras have also been collected from this area. A map of the sanctuary is provided.

Introduction

The creation of Wildlife Sanctuaries makes it possible to conserve the wild animals and plants thereby enabling the typical fauna and flora of India to be maintained to some extent. Mudumalai Wildlife Sanctuary lies between 11°32′ and 11°43′ N and 76°22′ and 76°45′ E and is situated along the eastern slopes of the Western Ghats. It forms the forest of the northern and north western side of the Nilgiri or Blue Mountains. The sanctuary is bounded on the north by the Bandipur National Park of Karnataka and on the west and south west by Kerala State (Map).

Topography: The sanctuary consists of undulating hills with elevations varying from 350 to 1250 m. Many streams drain the sanctuary, the principal ones being (1) Moyar which flows along the borders of Tamil Nadu and Karnataka (2) Benne Hole draining the western part of the sanctuary and (3) Biden Halla which flows into the Moyar. Moyar is the most important source of water in the sanctuary, since most of the other streams dry up during the summer months.

Geology and soil: The rocks are of typical archaean biotite and hornsblendic gneiss with intensive bunds of charnokite and much younger biotite-granite, pegmatite and basic doleric dykes. Two kinds of soil, namely black sandy loam and red heavy loam may be recognised in the area. The red soil is confined to the southern part of the sanctuary.

Climate and rainfall: The sanctuary is warmer than the rest of the area in the district. April, May and June are the hottest months and December and January are the coldest months. The rainfall varies greatly in different parts of the sanctuary. The western side receives more rainfall than the eastern part during the south-west monsoon period between June and September. In the eastern side most of the rainfall falls during the north-east monsoon period between October and December. The average annual rainfall is about 1420 m.

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Vegetation

The vegetation varies in different parts of the sanctuary due to the variation in the extent of rainfall within the limits of the sanctuary and the period of its occurrence, and presents more luxuriance in October and November. Three main types of vegetation are met with: 1. Tropical moist deciduous, 2. Tropical dry deciduous and 3. Southern tropical thorn forest. In certain places mixed type of vegetation is noticed and demarcation between the first and second type and between the second and third type becomes difficult.

Tropical moist deciduous: In Benne block (western side of the sanctuary) this type of forest is encountered because of high rainfall when compared to the other blocks. *Bambusa arundinaceae* is common and characteristic of this type. The forest is leafless during the dry season in March-April though there is a good covering of evergreen species in the underwood with shrubs such as *Toona ciliata, Euodia lunu-ankenda, Glochidion velutinum* and *Viburnum punctatum*. The prominent tree species which constitute the forest are: *Terminalia tomentosa, T. crenulata, T. bellerica, Schleichera oleosa, Butea monosperma, Linociera malabarica, Schrebera swietenioides* and *Pterocarpus marsupium*. The undergrowth consists of *Antidesma diandrum, Clerodendrum serratum, C. viscosum, Desmodium pulchellum, Flemingia strobilifera, F. wightiana* and *Callicarpa tomentosa*.

Due to the heavy rainfall and inadequate drainage, swamps are of frequent occurrence in this region.

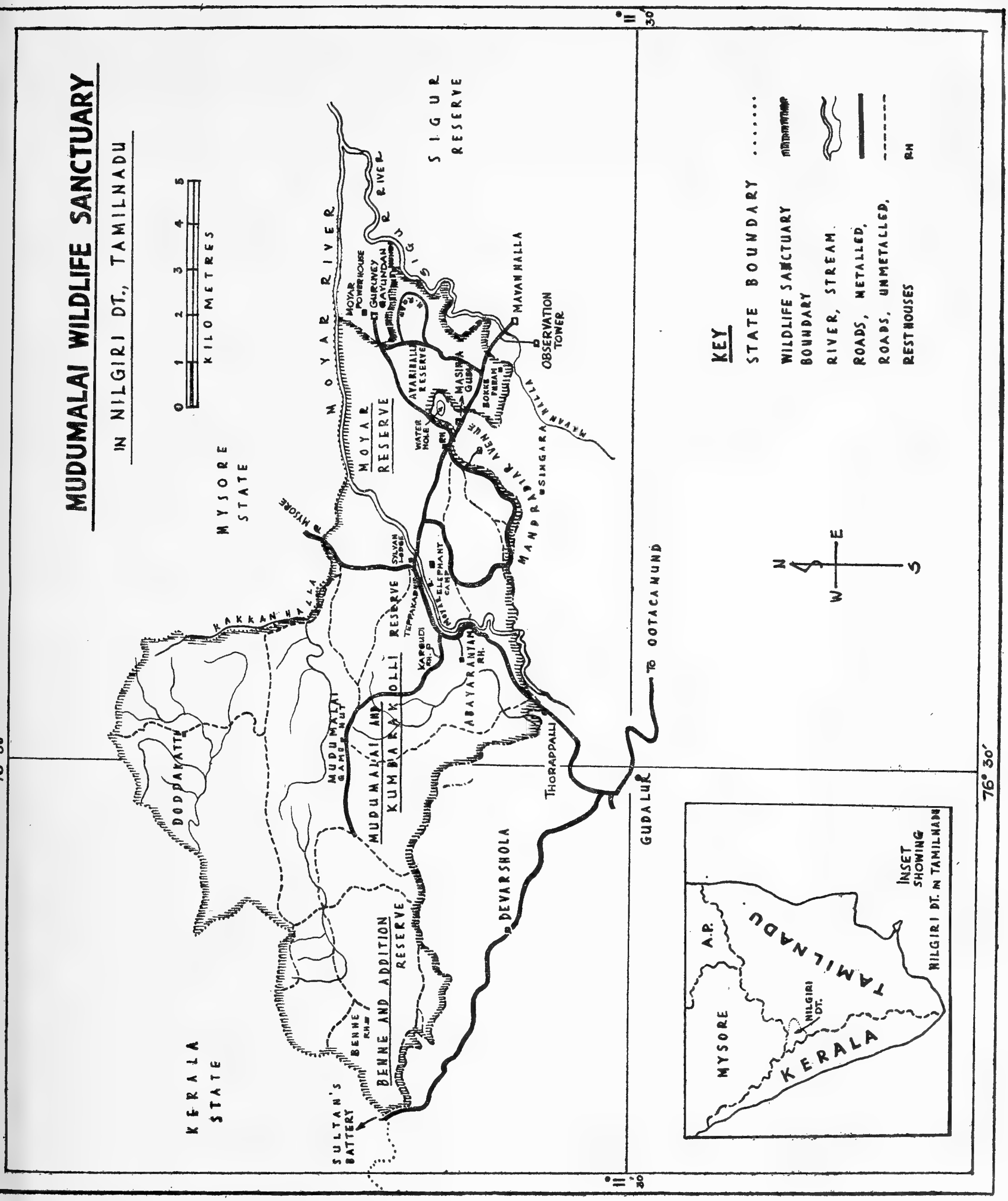
Tropical dry deciduous forest: This type of forest is confined to the eastern side of the sanctuary. It is composed of trees, practically all of which are deciduous during the dry season. It merges gradually into thorn forests wherever the rainfall is inadequate. *Anogeissus latifolia* is the dominant species. Other common tree species are: *Buchanania lanzan, Tectona grandis, Diospyros montana, Semecarpus anacardium, Givotia rottleriformis, Lannea coromandeliana, Dalbergia latifolia, Bombax ceiba, Madhuca indica, Gmelina arborea, Mitragyna parvifolia* and *Wrightia tinctoria*. Some of the shrubs and climbers worthy of mention are *Carissa carandas, Maytenus emarginata, Scutia myrtina, Argyreia cuneata, Ventilago maderaspatana* and *Hiptage benghalensis*.

Grasses like *Heteropogon contortus* and *Themeda cymbaria* come up after the rains and give good grazing for wild animals. *Habenaria plantaginea*, a terrestrial orchid, is found in association with *Themeda cymbaria*. The forest fires begin in February and burn the grasses over extensive areas till the dry spell ends in April.

Southern tropical thorn forest: This type of forest also known as scrub jungle is dominated by *Acacia* spp. Sometimes elements of dry deciduous type are also mixed up in this forest and hence a clear demarcation cannot be made here. However, the predominance of thorny species together with plants of fleshy nature, both of which are xerophytic adaptations, are characteristics of this vegetation. Parts of Avarihalla, Moyar and Bokkapuram reserves constitute this type. The floristic constituents are: *Acacia chundra, A. leucophloea, Albizzia amara, Canthium parviflorum, Xeromphis spinosa, Zizyphus oenoplia, Capparis grandiflora, C. sepiaria, Barleria buxifolia, B. mysorensis* and *B. prionitis*.

Succulents like *Opuntia dillenii* and *Caralluma adscendens* are common in the open forests.

On the banks of Moyar and along the streams, narrow strips of riverine vegetation



Map. Mudumalai Wildlife Sanctuary in Nilgiri District, Tamil Nadu.

is noticed. The prominent species are *Linociera malabarica, Salix tetrasperma, Bischofia javanica, Terminalia arjuna, Vitex altissima, Diospyros peregrina, D. assimilis, Drypetes roxburghii, Memecylon edule* and *Mallotus muricatus. Homonoia riparia,* a rheophytic shrub, is well adapted to water currents in Moyar river.

Almost the entire sanctuary is exploited for forest produce. It supports a number of Teak plantations, particularly in the Benne Block and plantation of *Eucalyptus* is found in Masinagudi area. Bamboo plantation for rayon mills in Kerala has also gained importance during the last few years. The timber extraction includes both clear felling and selective cuttings.

The minor forest produce includes wild honey, bees wax, bark lichen, soapnut, tamarind, gallnut for medicinal use from *Terminalia chebula* and *T. bellerica,* antlers, etc.

Mudumalai sanctuary, like many other sanctuaries in India, suffers from human interference. Some of the contributing factors are population pressure, denudation of forests, disturbance of the natural condition by the plantation of blue gum, wattles and other such exotics, use of insecticides, excessive cattle grazing which leads to soil erosion and the passing of unhealthy cattle through the sanctuary, etc. During one of our visits a big fair was in progress inside the sanctuary at the Bokkapuram Temple which is said to be an annual feature. This must certainly be a great source of annoyance and disturbance to the wildlife.

Keeping all these factors in mind it was decided to record the floral wealth of the sanctuary before it is adversely affected by man. It would be worthwhile to establish collaboration between the botanists and zoologists to establish as to which floristic and faunistic constituents are utilized by the wildlife for their needs, so that managerial practices could be orientated in the best interest of the wildlife.

BOTANICAL EXPLORATION

The earliest plant collections from the Mudumalai Wildlife Sanctuary area were made by R. H. Beddome, M. A. Lawson, C. A. Barber, J. S. Gamble and G. V. Narayana and S. R. Raju. K. Subramanyam in 1956 made collections in Benne block under the auspices of the Botanical Survey of India. The recent explorations, based on which this paper has been written, were undertaken between 1970 and 1973 by B. D. Sharma, B. V. Shetty, K. Vivekananthan and N. C. Rathakrishnan in eight field trips. Sporadic collections of N. P. Balakrishnan are also included. The collections are deposited in the Madras Herbarium, Coimbatore (MH).

This enumeration paper deals with 693 field numbers of flowering plants and ferns. It includes 506 vascular plants belonging to 328 genera spread over 98 families. The families of flowering plants are arranged according to Bentham & Hooker's Classification with certain exceptions to accommodate recent changes in the delimitation of families. Ferns are arranged based on the system followed by Bir & Vasudeva (1971) and Holttum (1954). Genera and species are arranged under their respective families in an alphabetical order. The currently valid names are given and wherever necessary the synonyms appearing in Gamble's Flora are given below. New records not reported by Gamble & Fischer (1915-1936) in the FLORA OF THE PRESIDENCY OF MADRAS are marked with an asterisk.

DICOTYLEDONS

Annonaceae

Uvaria narum (Dunal) Wt. & Arn.
Scandent shrub with yellow fls., rare.
Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35450.

Menispermaceae

Cissampelos pareira Linn. var. *hirsuta* (Buch.-Ham. ex DC.) Forman
C. pareira Linn.
Climber with greenish yellow fls., common.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34349; Circular road, 900 m, 24-6-1970, *Shetty* 34385; Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35405.

Cruciferae (Brassicaceae)

Coronopus didymus (Linn.) Sm.
Senebiera didyma Pers.
Small herb with white fls., occasional.
Benne, 1200 m, 19-1-1961, *Shetty* 11933.

Capparaceae

Capparis grandiflora Wall. ex Hook. f. & Thoms.
Shrub with white or yellow fls., occasional.
Bokkapuram R.F., 925 m, 17-4-1971, *Rathakrishnan* 37924.

C. sepiaria Linn.
Large straggling shrub in frs., common.
Avarihalla R.F., 950 m, 18-8-1970, *Sharma* 35611.

Cleome felina Linn. f.
Annual erect herb with pink fls., occasional.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38999.

C. monophylla Linn.
Erect herb with purple fls., occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35404.

Violaceae

Hybanthus enneaspermus (Linn.) F.V. Muell.
Ionidium suffruticosum Ging.
Perennial woody undershrub with red fls., common.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35722.

Bixaceae

Cochlospermum religiosum (Linn.) Alston.
C. gossypium DC.
Deciduous tree with golden yellow fls., rare.
Moyar bank, 550 m, 16-2-1972, *Sharma* 39820.

Flacourtiaceae

Flacourtia ramontchii L'Herit.
Shrub with yellow fls., occasional.
Moyar R.F., 925 m, 15-2-1972, *Sharma* 39804.

Pittosporaceae

Pittosporum floribundum Wt. & Arn.
Small tree with yellow fls., & frs., rare.
Theppakadu, 850 m, 27-10-1972, *Vivekananthan* 43091.

Polygalaceae

Polygala chinensis Linn.
Prostrate herb with greenish yellow fls., & frs., common.
Mudumalai R.F., 900 m, 24-6-1970, *Shetty* 34388;
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35584.

P. elongata Klein. ex Willd.
Annual herb with yellow fls., occasional.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34358.

P. rosmarinifolia Wt. & Arn.
Annual herb, rare.
Masinagudi, 950 m, November 1884, *Gamble* 15413.

Caryophyllaceae

Drymaria cordata Willd. ex Roem. & Schult.
Diffuse herb, common.
Theppakadu, 850 m, Nov. 1889, *Lawson* s.n. (MH 2649).

Dipterocarpaceae

Shorea talura Roxb.
Tree in fls., very rare.
Mudumalai R.F., 900 m, *Beddome* s.n. (MH 3419).

Malvaceae

Abelmoschus angulosus Wall. ex Wt. & Arn.
Hibiscus abelmoschus Linn.
Herb in frs., occasional.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35588.

Bombax ceiba Linn.
B. malabaricum DC.
Large tree with scarlet fls., rare.

Theppakadu, 900 m, August 1886, *Gamble* 17870; Moyar R.F., 925 m, 15-2-1972, *Sharma* 39806.

Hibiscus lunarifolius Willd.
Erect herb with yellow fls., occasional.
Kargudi, 975 m, 28-10-1972, *Vivekananthan* 43101.

H. ovalifolius (Forsk.) Vahl
H. micranthus L.f.
Shrub with white fls., common.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35720, 19-4-1971, *Rathakrishnan* 37959.

H. lobatus (J. A. Murray) O. Ktze.
H. solandra L'Herit.
Erect herb with yellow fls. & frs., common.
Mudumalai-Kargudi, 800 m, 23-9-1928, *Narayana & Raju* 18316; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35497.

Kydia calycina Roxb.
Tree with white fls., common.
Kargudi, 975 m, 28-10-1972, *Vivekananthan* 43099.

Sida acuta Burm. f.
Undershrub with yellow fls. & frs., common.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10475.

S. glutinosa Comm. ex Cav.
Undershrub with orange fls., occasional.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35597.

S. orientalis Cav.
Shrub in fls., occasional.
Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43051.

Thespesia lampas (Cav.) Dalz. & Gibs.
Hibiscus lampas Cav.
Undershrub with yellow fls., rare.
Benne, 900 m, November 1886, *Gamble* 18367; Birala, 850 m, 26-10-1972, *Vivekananthan* 43080.

Urena sinuata Linn.
Undershrub with pink fls., common.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38986.

STERCULIACEAE

Byttneria herbacea Roxb.
Herb with purple fls., common.
Mudumalai, 850 m, 24-6-1970, *Shetty* 34402.

Eriolaena quinquelocularis (Wt. & Arn.) Wt.
Small tree with yellow fls., rare.
Mudumalai, 900 m, 24-6-1970, *Shetty* 34386; Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35447.

Helicteres isora Linn.
Shrub with red fls., common.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10492; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35493.

Sterculia urens Roxb.
Tree with reddish-brown fls. & frs., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35571.

S. villosa Roxb.
Tree with yellow fls., streaked with pink, occasional.
Mudumalai, 850 m, February 1887, *Gamble* s.n. (MH 4740).

Waltheria indica Linn.
Undershrub with yellow fls., common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35406.

TILIACEAE

Grewia abutilifolia Vent. ex Juss.
G. aspera Roxb.
Shrub with white fls. & frs., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35385; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40764 & 25-10-1972, *Vivekananthan* 43054.

G. disperma Rottl. ex Spr.
Shrub with yellow fls., occasional.
Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35524.

G. hirsuta Vahl
Shrub with white fls. & frs., very common.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10487; Doddagatti, 900 m, 23-6-1970, *Shetty* 34359; Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35399; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43061.

G. orbiculata Rottl.
G. rotundifolia Juss.
Small tree with yellow fls., occasional.
Moyar R.F., 925 m, 21-4-1971, *Rathakrishnan* 38016.

G. tiliifolia Vahl.
Small tree with yellow fls. & frs., common.
Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35446; Avarihalla R.F., 925 m, 21-4-1971, *Ratha-*

krishnan 38030; Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40769.

Triumfetta rhomboidea Jacq.
Herb with yellow fls. & frs., common.
Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43067.

LINACEAE

Erythroxylon monogynum Roxb.
Small tree with white fls., occasional.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35387.

MALPIGHIACEAE

Hiptage benghalensis (Linn.) Kurz
H. madablota Gaertn.
Straggling shrub with fragrant white fls., occasional.
Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35445.

OXALIDACEAE

Biophytum reinwardtii (Zucc.) Klotch.
Small herb with white yellow fls. & frs., common.
Theppakadu, 850 m, 25-10-1972, *Vivenkananthan* 43060.

B. sensitivum (Lin.) DC. var. *candolleanum* (Wt.) Edgew. & Hook f.
B. candolleanum Wt.
Small herb with yellow fls., common
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35391.

Oxalis corniculata Linn.
Small herb with yellow fls., rare.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10493.

BALSAMINACEAE

Impatiens chinensis Linn.
Annual herb in fls. & frs., rare.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10477.

RUTACEAE

Atalantia racemosa Wt. & Arn.
Small tree with white fls., common.
Moyar bank, 550 m, 16-2-1972, *Sharma* 39813.

Chloroxylon swietenia DC.
Small tree with white fls., common.
Moyar R.F., 925 m, 21-4-1971, *Rathakrishnan* 38018; Avarihalla R.F., 900 m, 20-2-1972, *Sharma* 39864.

Euodia lunu-ankenda (Gaertn.) Merr.
Small tree with white fls., common.
Benne, 1030 m, 18-7-1960, *Subramanyam* 10437.

Feronia limonia (Linn.) Swingle
Limonia crenulata Roxb.
Small tree in frs., occasional.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38924.

Toddalia asiatica (Linn.) Lamk. var. *gracilis* Gamble
Climbing shrub with white fls., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35386.

BURSERACEAE

Commiphora caudata (Wt. & Arn.) Engl.
Tree in frs., common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35565.

Garuga pinnata Roxb.
Tree with yellow fls. & frs., common.
Doddagatti-Kargudi, 900 m, 23-6-1970, *Shetty* 34375; Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35413; Moyar R.F., 550 m, 16-2-1972, *Sharma* 39821; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40760.

MELIACEAE

Aglaia elaegnoidea (Juss.) Benth.
A. roxburghiana Hiern.
Small tree with pale yellow fls., rare.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35709.

Chukrasia tabularis A. Juss.
Large tree with white fls., rare.
Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40762.

Cippadessa baccifera (Roth) Miq.
Shrub in frs., occasional.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35382.

Soymida febrifuga (Roxb.) A. Juss.
Large tree in frs., common.
Moyar bank, 600 m, 19-4-1971, *Rathakrishnan* 37978.

Toona ciliata Roem.
Cedrela toona Roxb.
Large tree in frs., rare.

Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40777.

OLACACEAE

Olax scandens Roxb.
Climbing shrub in frs., common.
Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35436.

OPILIACEAE

Cansjera rheedii Gmel.
Climbing shrub with pale green fls., very common.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35728 & 23-11-1971, *Rathakrishnan* 38983.

Opilia amentacea Roxb.
Climbing shrub with pale green fls., common.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37968.

AQUIFOLIACEAE

Ilex malabarica Bedd.
Tree in fls., rare.
Mudumalai, 900 m, *Beddome* s.n. (MH 9757).

CELASTRACEAE

Celastrus paniculatus Willd.
Climbing shrub in frs., very common.
Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35434.

Elaeodendron paniculatum Wt. & Arn.
Small tree with greenish yellow fls., common.
Avarihalla R.F., 900 m, 20-2-1972, *Sharma* 39866.

E. roxburghii Wt. & Arn.
E. glaucum auct. non Pers.
Small tree with yellow fls., common.
Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35435; Moyar bank, 600 m, 17-4-1971, *Rathakrishnan* 37975.

Maytenus emarginata (Willd.) Ding Hou
Gymnosporia montana Benth.
Small tree with white fls., common.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38994; Moyar R.F., 925 m, 15-2-1972, *Sharma* 39801.

Pleurostylia opposita (Wall.) Alston
P. wightii Wt. & Arn.
Small tree in frs., common.
Masinagudi, 900 m, August 1886, *Gamble* 17910; Moyar bank, 550 m, 22-8-1973, *Sharma* 35715.

HIPPOCRATEACEAE

Loeseneriella pauciflora (DC.) A. C. Smith
Hippocratea obtusifolia Roxb.
Climbing shrub with yellow fls., occasional.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38982 & 16-2-1972, *Sharma* 39810.

RHAMNACEAE

Scutia myrtina (Burm. f.) Kurz
Straggling shrub with pale green fls., common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35415; Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38920.

Zizyphus oenoplia Mill.
Straggling shrub with greenish yellow fls. & frs., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35378; Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35537; Birala, 850 m, 26-10-1972, *Vivekananthan* 43077.

Z. xylopyrus (Retz.) Willd.
Small tree with yellow fls. & frs., common.
Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35438; Moyar R.F., 925 m, 21-4-1971, *Rathakrishnan* 38020; Mudumalai, 900 m, 11-4-1972, *Vivekananthan* 40789.

VITACEAE

Ampelocissus araneosa Planch.
Climbing shrub in frs., occasional.
Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35522.

Cissus discolor Bl.
Climber in fls., occasional.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10394.

C. gigantea (Bedd.) Planch.
Climbing shrub in frs., rare.
Theppakadu, 950 m, August 1886, *Lawson* s.n. (MH 11263).

C. glauca Roxb.
Climbing shrub with pink fls., common.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37965 & 16-2-1972, *Sharma* 39812.

C. quadrangularis Linn.
Climbing shrub with yellow fls., very common.

Moyar R.F., 925 m, 21-4-1971, *Rathakrishnan* 38022.

C. pallida (Wt. & Arn.) Planch.
Erect shrub in frs., rare.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35574.

Leea crispa Linn.
Shrub in greenish fls., occasional.
Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35533.

L. edgeworthii Santapau
L. aspera Edgew.
Undershrub in fls., common.
Benne R.F., 1000 m, 19-7-1960, *Subramanyam* 10474; Doddagatti, 900 m, 23-6-1970, *Shetty* 34353.

SAPINDACEAE

Allophylus rheedii (Wt.) Radlk.
Large shrub in fls., common.
Benne R.F., 850 m, 27-6-1970, *Shetty* 34434.

A. serratus (Roxb.) Kurz
Small tree with white fls., common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35421; Northern Hay R.F., 1000 m. 16-8-1970, *Sharma* 35521.

A. serrulatus (Wt.) Radlk.
Small tree in fls., occasional.
Bokkapuram, 1000 m, August 1886, *Gamble* 17943.

Cardiospermum canescens Wall.
Climbing herb with white fls., common.
Masinagudi, 1000 m, November 1886, *Gamble* 18457.

Filicium decipiens (Wt. & Arn.) Thw.
Tree with greenish buds, rare.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35416.

Sapindus emarginatus Vahl
Tree with white fls., occasional.
Masinagudi, 1000 m, August 1886, *Gamble* 17969.

S. laurifolius Vahl
Tree with yellow fls., occasional.
Avarihalla R.F., 910 m, 2-11-1971, *Rathakrishnan* 38916.

Schleichera oleosa (Lour.) Oken.
S. trijuga Willd.
Large tree in frs., common.
Mudumalai, 1100 m, *Gamble* s.n. (MH 11613); Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40756; Kargudi, 950 m, 12-4-1972, *Vivekananthan* 40802.

ANACARDIACEAE

Lannea coromandelica (Houtt.) Merr.
Odina wodier Roxb.
Small tree with yellowish green fls., & frs., occasional.
Theppakadu 850 m, August 1886, *Lawson* s.n. (MH 12104); Moyar bank, 530 m, 16-2-1972, Sharma 39818.

Mangifera indica Linn.
Tree along riverside in frs., occasional.
Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40750.

Rhus mysorensis G. Don.
Small tree with yellow fls., & frs., common.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38993 & 16-2-1972, *Sharma* 39819.

Semecarpus anacardium Linn. f.
Tree with greenish yellow fls. & frs., very common.
Mudumalai, 1100 m, November 1886, *Gamble* 17961; Moyar R.F., 900 m, 17-8-1970, *Sharma* 35577; Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38927.

PAPILIONACEAE

Alysicarpus bupleurifolius (Linn.) DC.
Herb with light pink fls., common.
Moyar R.F., 900 m, 18-8-1870, *Sharma* 35582.

A. monilifer (Linn.) DC.
Prostrate herb with pink fls., common.
Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43066.

Atylosia scarabaeoides (Linn.) Benth.
Twining herb with yellow fls. & frs., common.
Moyar R.F., 925 m, 15-2-1972, *Sharma* 39803; Mudumalai, 850 m, 27-10-1972, *Vivekananthan* 43095.

Butea monosperma (Lamk.) Taub.
Small tree with red fls. & frs., common.
Benne, 1125 m, 21-1-1961, *Shetty* 11959; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40761.

Crotalaria calycina Schrank
Herb with pale yellow fls., occasional.
Theppakadu, 850 m, November 1886, *Gamble* 18372.

C. dubia Grah. ex Benth.
Undershrub with fls. and frs. occasional.
Benne, 1125 m, November 1884, *Gamble* 15329, 21-1-1961, *Shetty* 11957.

C. laevigata Lamk.
Shrub with yellow fls., occasional.
Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43050.

C. medicaginea Lamk. var. *neglecta* (Wt. & Arn.) Baker
C. medicaginea Lamk.
Herb with yellow fls., occasional.
Theppakadu, August 1886, *Lawson* s.n. (MH 13271).

C. mysorensis Roth
Herb in frs., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35596.

C. pallida Ait.
C. striata DC. var. *acutifolia* Trim.
Shrub with yellow fls., common.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38980.

C. verrucosa Linn.
Shrub with pale blue fls., common.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38996.

C. walkeri Arn.
Undershrub with yellow fls. & frs., common.
Benne, 1125 m, 19-1-1961, *Shetty* 11932.

Dalbergia lanceolaria Linn. f.
Medium-sized tree in frs., common.
Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35441.

D. latifolia Roxb.
Medium-sized tree with white fls., common.
Avarihalla R.F., 950 m, 19-8-1970, *Sharma* 35620; Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35442.

D. paniculata Roxb.
Medium-sized tree in frs., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35569.

Derris indica (Lamk.) Bennet
Pongamia pinnata (Linn.) Pierre
Small tree with pinkish fls. & frs., common.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35723; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40743.

Desmodium heterocarpum (Linn.) DC.
D. polycarpum DC. var. *trichocaulon* Baker
Undershrub with purple fls., common.
Birala, 850 m, 26-10-1972, *Vivekananthan* 43075.

D. botorium (Houtt.) Merr.
D. gyrans DC.
Undershrub with pinkish fls. & frs., common.
Benne, 1200 m, November 1886, *Gamble* 18405 & 21-1-1961, *Shetty* 11956; Birala, 850 m, 26-10-1972, *Vivekananthan* 43074.

D. velutinum (Willd.) DC.
D. latifolium DC.
Undershrub with fls. & frs., very common.
Benne, 1200 m, November 1886, *Gamble* 18420; Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38991; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43053.

D. ormocarpoides DC.
Undershrub with pinkish fls., occasional.
Birala 850 m, 26-10-1972, *Vivekananthan* 43072.

D. pulchellum (Linn.) Benth.
Shrub with pale yellow fls. & frs., very common.
Benne, 1125 m, 21-1-1961, *Shetty* 11955; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43052.

D. triangulare (Retz.) Merr.
D. cephalotes Wall. var. *congestum* Prain
Shrub with white fls. & frs., common.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10481; Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35545; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43063.

Dunbaria ferruginea Wt. & Arn.
Climber with yellow fls., occasional.
Moyar R.F., 525 m, 23-11-1971, *Rathakrishnan* 38984.

Erythrina suberosa Roxb.
Tree with scarlet fls., occasional.
Mudumalai, 1100 m, *Beddome* s.n. (MH 15875).

Flemingia strobilifera R. Br. ex Ait.
Shrub with white fls., common.
Benne, 1200 m, 21-1-1960, *Shetty* 11949.

F. wightiana Grah.
Shrub in frs., common.
Benne, 1125 m, 19-1-1961, *Shetty* 11930.

Glycine javanica Linn.
Climber with red fls. & frs., common.
Theppakadu, 850 m, November 1884, *Gamble*

15664; Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38926.

Indigofera cassioides Rottl. ex DC.
I. pulchella Roxb.
Shrub with purple fls. & frs., common.
Thorapalli-Kargudi, 850 m, 26-10-1972, *Vivekananthan* 43086.

I. cordifolia Heyne ex Roth
Herb with red fls. & frs., common.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38995.

I. hirsuta Linn.
Herb with red fls. & frs., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35598.

I. parviflora Heyne ex Wt. & Arn.
Herb with lilac fls., common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38923.

I. spicata Forsk.
I. endecaphylla Jacq.
Trailing herb with red fls. & frs., common.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10468; Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35520.

I. trita Linn. f. ssp. *subulata* (Vahl ex Poir.) Ali
I. subulata Vahl
Undershrub with red fls., common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38928.

I. vestita Baker
Undershrub in frs., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35580.

I. wightii Grah. ex Wt. & Arn.
Shrub with yellowish-red fls. & frs., common.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10496; Doddagatti, 900 m, 23-6-1970, *Shetty* 34357.

Pterocarpus marsupium Roxb.
Large tree with yellow fls. & frs., common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35548.

Rhynchosia albiflora (Sims) Alston
R. cyanosperma Benth.
Climber in fls., common.
Theppakadu, 850 m, November 1884, *Gamble* 15665; Mudumalai, 1100 m, 27-10-1972, *Vivekananthan* 43093.

R. densiflora (Roth) DC.
Twiner with yellow fls., common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38922.

R. minima (Linn.) DC.
Trailing herb with yellow fls., very common.
Mudumalai, 900 m, 24-6-1970, *Shetty* 34390.

R. rothii Benth. ex Aitch.
P. sericea Span.
Climbing shrub with purple fls., scarce.
Theppakadu, 850 m, November 1884, *Gamble* 15662.

R. rufescens DC.
Twining herb with yellow fls., common.
Masinagudi, 1000 m, November 1884, *Gamble* 15661; Theppakadu, 850 m, November 1886, *Gamble* 18443; Benne 1200 m, 21-1-1961, *Shetty* 11958; Bokkapuram R.F., 1000 m, 13-8-1971, *Sharma* 35439.

Smithia geminiflora Roth
Herb with yellow fls., common.
Benne, 1125 m, 21-1-1961, *Shetty* 11946.

Sophora glauca Lesch.
Shrub with purple fls., occasional.
Kargudi, 950 m, 12-4-1972, *Vivekananthan* 40804.

Tephrosia purpurea (Linn.) Pers.
Herb with pink or white fls. & frs., common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35554; Masinagudi, 950 m, 19-8-1970, *Sharma* 35615.

T. tinctoria Pers.
Undershrub with pink fls., common.
Moyar R.F., 900 m, 19-8-1970, *Sharma* 35588.

Uraria hamosa Wall. ex Wt.
Straggling shrub with pink fls., common.
Benne, 1050 m, November 1886, *Gamble* 18424.

U. lagopodioides Desv. ex DC.
Undershrub with pink fls., occasional.
Mudumalai, 1100 m, *Beddome* s.n. (MH 14804); Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35539.

Vigna radiata (Linn.) Witczek. var. *sublobata* (Roxb.) Verdc. *Phaseolus sublobatus* Roxb.
Twining herb with yellow fls. & frs., occasional.
Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35527.

CAESALPINIACEAE

Piliostigma malabaricum (Roxb.) Benth. *Bauhinia malabarica* Roxb.
Tree with yellow fls., common.

Mudumalai, 1100 m, August 1886, *Gamble* 17933 & 20-7-1960, *Subramanyam* 10483.

P. racemosa (Lamk.) Benth. *Bauhinia racemosa* Lamk.
Tree with yellow fls., common.
Bokkapuram R.F., 925 m, 17-4-1971, *Rathakrishnan* 37981; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40746 & 25-10-1972, *Vivekananthan* 43059.

Caesalpinia mimosoides Lamk.
Climbing shrub with yellow fls. & frs., common.
Benne, 1125 m, November 1886, *Gamble* 18422 & 21-1-1961, *Shetty* 11938.

Cassia auriculata Linn.
Shrub with yellow fls., common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35551.

C. fistula Linn.
Small tree with yellow fls., common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35557; Kargudi, 950 m, 12-4-1972, *Vivekananthan* 40800.

C. hirsuta Linn.
Shrub with yellow fls. & frs., common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35423.

**C. intermedia* Sharma, Vivek. & Rathak. in Proc. Ind. Acad. Sci. (sec. B) 80:301.1975.
Shrub with yellow fls. & frs.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35602; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40758.

C. mimosoides Linn.
Herb with yellow fls., common.
Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35523.

C. sophera Linn.
Undershrub with yellow fls. & frs., common.
Mudumalai 1100 m, 20-7-1960, *Subramanyam* 10484; Kargudi, 975 m, 28-10-1972, *Vivekananthan* 43102.

C. tora Linn.
Undershrub in frs., common.
Theppakadu, 850 m, November 1886, *Gamble* 18441.

MIMOSACEAE

Acacia canescens Grah.
Scandent shrub with yellow fls. & frs., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35400; Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38911.

A. chundra Willd.
A. sundra DC.
Small tree with pale yellow fls., common.
Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35433; Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38910.

A. leucophloea Willd.
Tree in yellow flower heads, rare.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35553.

A. torta (Roxb.) Craib
Climbing shrub with white flower heads, occasional.
Kargudi, 1000 m, 24-6-1970, *Shetty* 34397; Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35529.

Albizzia amara Boivin.
Small tree with yellowish flower heads, occasional.
Avarihalla R.F., 900 m, 20-2-1972, *Sharma* 39865.

A. lebbek (Linn.) Benth.
Large tree with white flower heads, common.
Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40772.

Mimosa pudica Linn.
Undershrub with pinkish flower heads, rare.
Avarihalla R.F., 950 m, 19-8-1970, *Sharma* 35618.

COMBRETACEAE

Anogeissus latifolia (Roxb.) Bedd.
Medium-sized tree with yellow fls. & frs., very common.
Mudumalai, 1100 m, 23-9-1928, *Narayana & Raju* 18314; Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35535; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43070.

Combretum ovalifolium Roxb.
Climbing shrub with pale green fls., common.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37982 & 16-2-1972, *Sharma* 39807.

Terminalia arjuna (Roxb. ex DC.) Wt. & Arn.
Large tree with yellow fls. on river banks, rare.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37958.

T. bellerica Roxb.
Tree with greenish yellow fls., rare.
Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40774.

T. chebula Retz.
Small tree with pale green fls., common.
Bokkapuram R.F., 925 m, 17-4-1971, *Rathakrishnan* 37928.

T. coriacea (Roxb.) Wt. & Arn.
Tree in fls., rare.
Mudumalai, 900 m, 11-4-1972, *Vivekananthan* 40791.

T. crenulata Roth
Tree in fls. & frs., common.
Benne R.F., 875 m, 27-6-1970, *Shetty* 34427; Northern Hay R.F., 15-8-1970, *Sharma* 35503; Birala-Thorapalli, 850 m, 26-10-1972, *Vivekananthan* 43079.

T. paniculata Roth
Tree in fls., rare.
Doddagati, 900 m, 23-6-1970, *Shetty* 34360.

T. tomentosa Wt. & Arn.
Tree with yellow fls. & frs., occasional.
Kargudi-Mudumalai, 850 m, 23-9-1928, *Narayana & Raju* 18313; Mudumalai, 900 m, 11-4-1972, *Vivekananthan* 40793.

MYRTACEAE

Psidium guajava Linn.
Small cultivated tree in frs., occasional.
Benne R.F., 850 m, 27-6-1970, *Shetty* 34432 & 10-4-1972, *Vivekananthan* 40767.

Syzygium cumini (Linn.) Skeels
Tree with pale yellow fls., common.
Bokkapuram R.F., 925 m, 17-4-1971, *Rathakrishnan* 37925; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40744.

MELASTOMATACEAE

Memecylon edule Roxb.
Small tree in frs., rare.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37979.

Osbeckia wynaadensis C.B. Cl.
Undershrub with purple fls. & frs., occasional.
Benne, 1125 m, 21-1-1961, *Shetty* 11944 & 11-4-1972, *Vivekananthan* 40779.

Sonerila tenera Royle
Very small herb with pink fls., rare.
Mudumalai, 1100 m, *Beddome* s.n. (MH 21380).

LYTHRACEAE

Lagerstroemia parviflora Roxb.
Tree with white fls., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35603; Mudumalai, 900 m, 11-4-1972, *Vivekananthan* 40788.

Rotala indica (Willd.) Kochne
Herb with pale pink fls. & frs., common.
Benne, 1125 m, 21-1-1961, *Shetty* 11961.

ONAGRACEAE

Ludwigia hyssopifolia (G. Don) Exell
Jussiaea linifolia Vahl
Undershrub with yellow fls. & frs., common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10450; Moyar R.F., 925 m, 24-11-1971, *Rathakrishnan* 39007.

L. peruviana (Linn.) Hara
Jussiaea speciosa Ridley
Undershrub with yellow fls. & frs., very common.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38981; Theppakadu, 850 m, 24-6-1970, *Shetty* 34401 & 9-4-1972, *Vivekananthan* 40752.

PASSIFLORACEAE

Passiflora calcarata Mast.
Climbing shrub with white fls. & frs., rare.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35417.

CUCURBITACEAE

Diplocyclos palmatus (Linn.) C. Jeffrey
Bryonopsis laciniosa auct. non. Naud.
Climber with yellow fls. & frs. very common.
Moyar R.F., 900 m, 3-10-1956, *Balakrishnan* 168 & 18-8-1970, *Sharma* 35609; *Benne,* 1125 m, 21-1-1961, *Shetty* 11947.

Coccinia cordifolia (Linn.) Cogn.
Climber with white fls., occasional.
Avarihalla R.F., 900 m, 19-8-1970, *Sharma* 35613.

Cucumis melo Linn. var. *agrestis* Naud.
C. pubescens Wall.
Climber in fls. & frs., rare.
Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43071.

Trichosanthes bracteata (Lamk.) Voigt. var. *tomentosa* Heyne

T. palmata Roxb. var. *tomentosa* C.B. Cl.
Large climber with white fls. & frs., common.

Theppakadu, 850 m, 27-10-1972, *Vivekananthan* 43098.

CACTACEAE

Opuntia dillenii Haw.
Shrub with yellow fls., common.
Avarihalla R.F., 950 m, 19-8-1970, *Sharma* 35612.

AIZOACEAE

Mollugo pentaphylla Linn.
Herb with white fls., common.
Bokkapuram R.F., 110 m, 12-8-1970, *Sharma* 35408.

UMBELLIFERAE (APIACEAE)

Pimpinella heyneana Wall. ex Kurz
Herb with white fls., occasional.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10457.

P. monoica Dalz.
Herb with white fls. & frs., common.
Theppakadu, 850 m, August 1886, *Lawson* s.n. (MH 23481); Doddagatti, 900 m, 23-6-1970, *Shetty* 34366; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35512.

CAPRIFOLIACEAE

Viburnum punctatum Buch.-Ham. ex D. Don
V. acuminatum Wall.
Tree with white fls. & frs., occasional.
Benne R.F., 1230 m, 27-1-1961, *Shetty* 11948 & 27-6-1970, *Shetty* 34428.

RUBIACEAE

Aidia candolleana (Wt. & Arn.) Swamin.
Randia candolleana Wt. & Arn.
Small tree in frs., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35568.

Borreria articularis (Linn. f.) F.N. Will.
B. hispida K. Sch.
Procumbent herb with pale blue fls., occasional.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35579.

B. ocymoides (Burm. f.) DC.
Herb with pale blue fls., rare.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10456.

Canthium dicoccum (Gaertn.) T. & B.
Plectronia didyma Kurz
Small tree with greenish fls., common.
Moyar bank, 550 m, 16-2-1972, *Sharma* 39808.

C. parviflorum Lamk.
Plectronia parviflora Bedd.
Shrub with white fls., very common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35560 & 21-4-1971, *Rathakrishnan* 38023; Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40775.

Exallage auricularia (Linn.) Bremek.
Oldenlandia auricularia K. Schum.
Herb with white fls., very common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10397; Doddagatti, 900 m, 23-6-1970, *Shetty* 37374.

Gardenia gummifera Linn. f.
Small tree in frs., occasional.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34363.

G. resinifera Roth
G. lucida Roxb.
Small tree in frs., occasional.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35727.

Ixora arborea Roxb. ex Sm.
I. parviflora Vahl
Small tree in frs., occasional.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37970.

Knoxia sumatrensis (Retz.) DC.
K. corymbosa Willd.
Herb with purple fls., occasional.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34369.

Mitragyna parvifolia (Roxb.) Korth
Large tree with pale yellow fls., rare.
Theppakadu, 850 m, August 1886, *Lawson* s.n. (MH 24020); Kargudi, 950 m, 12-4-1972, *Vivekananthan* 40801.

Morinda coreia Buch.-Ham.
M. tinctoria Roxb.
Small tree with white, scented fls., occasional.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37971.

Neanotis indica (DC.) Lewis
Anotis leschenaultiana Benth. & Hook. f.
Herb with purple fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10383.

Oldenlandia affinis (Roem. & Schult.) DC.
O. dichotoma Koen.
Herb with pale blue fls., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35586.

O. pumila (Linn. f.) DC.
O. crystallina Roxb.
Prostrate herb with white fls., occasional.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35595.

O. umbellata Linn.
Herb with lilac fls. and frs., common.
Mudumalai, 825 m, 24-6-1970, *Shetty* 34403.

Ophiorrhiza mungos Linn.
Undershrub with white fls. & frs., common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10440.

Pavetta indica Linn.
Large shrub with white fls., common.
Bokkapuram R.F., 925 m, 17-4-1971, *Rathakrishnan* 37926.

P. tomentosa Roxb. ex Sm.
P. indica Linn. var. *tomentosa* (Roxb. ex Sm.) Hook. f.
Shrub in frs., occasional.
Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35543.

Rubia cordifolia Linn.
Climber with white fls., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35380.

Tarenna asiatica (Linn.) O. Ktze. ex K. Schum.
Chomelia asiatica O. Kuntze
Shrub in frs., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35392.

Xeromphis malabarica (Lamk.) Raju
Randia malabarica Lamk.
Shrub in frs., occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35419.

X. spinosa (Thunb.) Keay
Randia brandisii Gamble
Shrub with white fls. & frs., very common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35379; Thorapalli, 850 m, 26-10-1972, *Vivekananthan* 43084.

COMPOSITAE (ASTERACEAE)

Acanthospermum hispidum DC.
Herb with yellow fls. & frs., occasional.
Kalhatti-Masinagudi, 1150 m, 23-8-1970, *Sharma* 35734.

Bidens biternata (Lour.) Merr. & Sheriff
B. pilosa auct. non Linn.
Herb with yellow fls., occasional.
Bokkapuram R.F., 1250 m, 14-8-1970, *Sharma* 35461.

Blainvillea acmella (Linn.) Philip.
B. rhomboidea Cass.
Herb with white fls., rare.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35594.

Blepharispermum subsessile DC.
Shrub in fls., rare.
Masinagudi, 1000 m, August 1886, *Lawson* s.n. (MH 27761); Moyar R.F., 900 m, 18-8-1970, *Sharma* 35600.

Blumea lacera (Burm. f.) DC.
Herb with yellow fls., common.
Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40759.

B. mollis (D. Don) Merr.
B. wightiana DC.
Herb in fls., common.
Benne, 1125 m, 19-1-1961, *Shetty* 11931.

Centratherum anthelminticum (Linn.) O. Kuntze
Herb with purple fls., rare.
Masinagudi, 1000 m, November 1886, *Gamble* 18470.

Conyza leucantha (D. Don) Ludlow & Raven
C. viscidula Wall.
Herb with pink fls., common.
Benne-Devarshola, 1225 m, 21-1-1961, *Shetty* 11942.

Cosmos sulphureus Cav.
Garden escape, with yellow fls.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35508.

Dichrocephala integrifolia (Linn. f.) O. Kuntze
D. latifolia DC.
Herb with yellow fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10396.

Emilia scabra DC.
Herb with red fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10402.

Laggera alata (D. Don) Sch.-Bip.
Herb with purple fls., occasional.
Benne, 1125 m, 21-1-1960, *Shetty* 11952.

Notonia grandiflora DC.
Undershrub with pale-yellow fls., common.

Moyar R.F., 900 m, 18-8-1970, *Sharma* 35605; Moyar bank, 550 m, 16-2-1972, *Sharma* 39814.

Senecio zeylanicus DC.
Herb with yellow fls. & frs., common.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10480.

Spilanthes paniculata Wall. ex DC.
S. acmella Murr.
Herb with yellow fls., common.
Benne-Devarshola, 1125 m, 21-1-1961, *Shetty* 11960.

Synedrella nodiflora Gaertn.
Herb with yellow fls., occasional.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35500.

Vernonia albicans DC.
Undershrub with pink fls., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35587.

Xanthium strumarium Linn.
Herb in frs., common.
Theppakkadu, 850 m, 9-4-1972, *Vivekananthan* 40747.

CAMPANULACEAE

Lobelia heyneana Roem. & Schult.
L. trialata Buch.-Ham. ex D. Don
Herb with pale blue fls. & frs., common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10455.

L. nicotianaefolia Heyne
Herb with white fls., common.
Benne-Devarshola, 1230 m, 21-1-1960, *Shetty* 11935.

PLUMBAGINACEAE

Plumbago zeylanica Linn.
Herb with white fls., occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35418.

MYRSINACEAE

Ardisia solanacea (Poir.) Roxb.
Shrub with pink fls. & frs. occasional.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34351; Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35420; Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40781.

Embelia tsjeriam-cottam (Roem. & Schult.) A. DC.
Shrub with pale green fls., occasional.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35989 & 17-4-1971, *Rathakrishnan* 37929.

SAPOTACEAE

Madhuca indica Gmel.
Bassia latifolia Roxb.
Large tree with cream-coloured fls. & frs., rare.
Moyar R.F., 925 m, 18-9-1971, *Rathakrishnan* 37956 & 15-2-1972, *Sharma* 39805.

M. longifolia (Linn.) Macbride
Bassia longifolia Linn.
Large tree with yellow fls., rare.
Moyar bank, 550 m, 16 2-1972, *Sharma* 39815.

Manilkara roxburghiana (Wt.) Dubard
Mimusops roxburghiana Wt.
Large tree with white fls. & frs., occasional.
Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35443; Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37987.

Mimusops elengi Linn.
Medium-sized tree with white fls., common.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37987; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40753.

EBENACEAE

Diospyros assimilis Bedd.
Large tree with yellow fls., rare.
Moyar bank, 550 m, 16-2-1972, *Sharma* 39817.

D. ebenum Koen. ex Retz.
Small tree with yellow fls., common.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37980.

D. montana Roxb.
Small tree in frs., common.
Northern Hay R.F., 900 m, August 1886, *Gamble* 18066; Moyar dam, 900 m, 17-8-1970, *Sharma* 35576; Avarihalla R.F., 900 m, 20-11-1971, *Rathakrishnan* 38912.

D. peregrina (Gaertn.) Gurke
Tree on riverside with yellow fls. & frs., very common.
Moyar bank, 550, 22-8-1970, *Sharma* 35714 & 19-4-1971, *Rathakrishnan* 37957.

OLEACEAE

Jasminum auriculatum Vahl
Climbing shrub with white fls., common.
Masinagudi, 1000 m, November 1884, *Gamble* 15416; Moyar R.F., 900 m, 18-8-1970, *Sharma* 35604.

J. malabaricum Wt.
Climbing shrub with fragrant, white fls., occasional.
Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40766.

J. rigidum Zenk.
Climbing shrub in frs., common.
Avarihalla R.F., 950 m, 19-8-1970, *Sharma* 35619; Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37984.

J. ritchiei C.B. Cl.
Climbing shrub with white fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10399 & 27-6-1970, *Shetty* 34433.

Ligustrum walkeri Dcne.
Small tree with white fls. & frs. occasional.
Theppakadu, 850 m, November 1889, *Lawson* s.n. (MH 31220); Benne, 1200 m, 19-7-1960, *Subramanyam* 10467.

Linociera malabarica Wall. ex G. Don
Small tree with white fls. & frs., common.
Benne R.F., 875 m, 21-1-1960, *Shetty* 11950 & 10-4-1972, *Vivekananthan* 40768.

Olea dioica Roxb.
Tree with white fls. & frs., common.
Benne-Devarshola, 1300 m, 21-1-1961, *Shetty* 11936; Bokkapuram R.F., 925 m, 17-4-1971, *Rathakrishnan* 37927; Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40770.

Schrebera swietenioides Roxb.
Tree in frs., occasional.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34365.

APOCYNACEAE

Alstonia venenata R. Br.
Shrub with white fls., occasional.
Mudumalai, 825 m, 24-6-1970, *Shetty* 34391.

Carissa carandas Linn.
Shrub with white or purple fls., common.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35713; Avarihalla R.F., 925 m, 21-4-1971, *Rathakrishnan* 38026.

C. paucinervia DC.
Shrub in frs., occasional.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35384.

Chonemorpha fragrans (Moon) Alston
C. macrophylla G. Don
Climber with white fls., rare.
Mudumalai, 1100 m, 1872, *Beddome* s.n. (MH 31926).

Plumeria rubra Linn.
P. acutifolia Poir.
Tree, fls. white tinged with yellow, cultivated.
Moyar R.F., 950 m, 19-4-1971, *Rathakrishnan* 37985.

Rauwolfia serpentina (Linn.) Benth. ex Kurz
Undershrub in frs., rare.
Benne, 1200 m, 19-7-1960, *Subramanyam* 10463.

Wrightia tinctoria R. Br.
Small tree with white fls. & frs., common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35550 & 19-4-1971, *Rathakrishnan* 37986.

ASCLEPIADACEAE

Asclepias curassavica Linn.
Undershrub with red fls., occasional.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35724; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40741.

Caralluma adscendens (Roxb.) Haw.
Fleshy herb, fls. yellow with pinkish streaks on the corolla lobes, rare.
Avarihalla R.F., 925 m, 21-4-1971, *Rathakrishnan* 38029.

Ceropegia hirsuta Wt. & Arn.
Climber, corolla greenish with pink dots, occasional.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35593.

Cryptolepis buchanani Roem. & Schult.
Climber in frs., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35591; Theppakadu, 850 m, 27-10-1972, *Vivekananthan* 43096.

Dregea volubilis (Linn. f.) Benth. ex Hook. f.
Marsdenia volubilis T. Cooke
Climbing shrub with green fls. & frs., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35607.

Gymnema sylvestre (Retz.) R. Br. ex Roem. & Schult.
Climber in frs., common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38929.

Holostemma annulare (Roxb.) K. Schum.
Climber with pink or white fls., occasional.
Masinagudi, 1000 m, August 1886, *Gamble* 18012.

Pergularia daemia (Forsk.) Choiv.
P. extensa N.E. Br.
Climber with yellow fls. & frs., common.
Masinagudi, 1000 m, November 1886, *Gamble* s.n. (MH 32406); Moyar R.F., 900 m, 18-8-1970, *Sharma* 35606.

Sarcostemma brunonianum Wt. & Arn.
Trailing leafless herb with yellow fls., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35559.

Secamone emetica R. Br.
Climber with yellow fls., occasional.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35401.

Tylophora indica (Burm. f.) Merr.
T. asthmatica Wt. & Arn.
Climber with yellow fls., occasional.
Moyar R.F., 925 m, 21-4-1971, *Rathakrishnan* 38021.

T. pauciflora Wt. & Arn.
Climber with yellow fls., occasional.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35710.

LOGANIACEAE

Strychnos potatorum Linn. f.
Small tree in frs., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35549.

GENTIANACEAE

Canscora diffusa R. Br.
Herb with pink fls., occasional.
Moyar bank, 550 m, 16-2-1972, *Sharma* 39822.

Exacum bicolor Roxb.
Herb, fls. white tinged with blue, rare.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10478.

Swertia angustifolia Buch.-Ham. var. *pulchella* Burkill
Herb with white fls., rare.
Theppakadu, 850 m, August 1886, *Lawson* s.n. (MH 33558).

BORAGINACEAE

Carmona microphylla (Lamk.) G. Don
Ehretia microphylla Lamk.
Shrub in frs., occasional.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38925.

Cordia monoica Roxb.
Tree in frs., common.
Masinagudi, 1000 m, November 1884, *Gamble* 15659; Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38917.

C. obliqua Willd. var. *tomentosa* (Wall.) Kozmi
C. wallichii G. Don
Tree in frs., common.
Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40757.

Cynoglossum zeylanicum (Vahl ex Honem) Thunb.
C. furcatum Wall.
Herb with blue fls. & frs., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10386; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40748.

Ehretia canarensis Miq. ex Gamble
Small tree with greenish yellow fls., common.
Kalhatti-Masinagudi, 1150 m, 23-8-1970, *Sharma* 35732; Thorapalli-Kargudi, 850 m, 26-10-1972, *Vivekananthan* 43085.

Trichodesma indicum (Linn.) Lehm.
Herb with blue fls., occasional.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35601.

CONVOLVULACEAE

Argyreia cuneata (Willd.) Ker-Gawl.
Climbing shrub with purple fls. & frs., very common.
Mudumalai, 1100 m, August 1886, *Gamble* 17877; Benne, 1100 m, 19-7-1960, *Subramanyam* 10461; Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35428; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43068.

A. pomacea (Roxb.) Choisy
Climber with purple fls., rare.
Masinagudi, 1100 m, August 1886, *Gamble* 18017.

A. setosa (Roxb.) Choisy
Lettsomia setosa Roxb.
Climber with pink fls., rare.
Theppakadu, 850 m, November 1886, *Gamble* 18466.

Evolvulus alsinoides (Linn.) Linn.
Prostrate herb with blue fls., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35583.

Ipomoea alba Linn.
Calonyction bona-nox Boj.
Climber with white fls., occasional.
Benne-Devarshola, 1225 m, 19-1-1961, *Shetty* 11941.

I. hederifolia Linn.
Quamoclit phoenicea Choisy
Twiner with red fls., occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35410.

I. muricata (Linn.) Jacq.
Calonyction muricatum G. Don
Climber with pink fls. & frs., occasional.
Kargudi, 975 m, 29-10-1972, *Vivekananthan* 43105.

I. staphylina Roem. & Schult.
Climbing shrub, fls. white with purple shade on the corolla tube, occasional.
Masinagudi, 1000 m, November 1886, *Gamble* 20431.

Lettsomia elliptica Wt.
Climber with pink fls., common.
Bokkapuram R.F., 1250 m, 14-8-1970, *Sharma* 35460.

Rivea ornata Choisy
Climbing shrub with white fls., common.
Masinagudi, 1000 m, November 1889, *Lawson* s.n. (MH 34364); Moyar R.F., 900 m, 17-8-1970, *Sharma* 35573 & 24-11-1971, *Rathakrishnan* 39000.

SOLANACEAE

Datura metel Linn.
Shrub with white fls., common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35424.

D. stramonium Linn.
Undershrub with white fls. & frs., common.
Kalhatti-Masinagudi, 1150 m, 23-8-1970, *Sharma* 35745.

Solanum giganteum Jacq.
Large shrub with pink fls. & frs., common.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35499; Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40778.

S. indicum Linn.
Undershrub with blue fls., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35394; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43057.

S. melongena Linn. var. *insanum* Prain
Shrub with pink fls., occasional.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38906.

S. nigrum Linn.
Herb with white fls. & frs., common.
Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35531.

S. torvum Sw.
Shrub with white fls. & frs., common.
Benne R.F., 875 m, 27-6-1970, *Shetty* 34426; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35510.

S. verbascifolium Linn.
Large shrub with white fls. & frs., occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35422.

* *S. viarum* Dunal
Shrub with white fls. & frs., common.
Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40749; Birala-Thorapalli, 850 m, 26-10-1972, *Vivekananthan* 43073.

SCROPHULARIACEAE

Artanema longifolia (Linn.) Vatke
A. sesamoides Benth.
Undershrub with purple fls. & frs., rare.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10444.

Lindernia antipoda (Linn.) Alston
Ilysanthes veronicaefolia Urban
Herb with pink fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10392.

Scoparia dulcis Linn.
Herb with white fls. & frs., common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10447; Theppakadu, 850 m, 24-6-1970, *Shetty* 34400; Moyar bank, 550 m, 22-8-1970, *Sharma* 35719.

Sopubia delphinifolia (Roxb.) G. Don
Herb with purple fls., occasional.
Moyar R.F., 925 m, 24-11-1971, *Rathakrishnan* 39003.

Striga angustifolia (D. Don) Sald.
S. euphrasioides auct. non Benth.
Hemiparasitic herb with white fls., rare.
Moyar R.F., 925 m, 24-11-1971, *Rathakrishnan* 39002.

S. lutea Lour.
Hemiparasitic herb with yellow fls., rare.
Moyar R.F., 925 m, 24-11-1971, *Rathakrishnan* 39006.

Bignoniaceae

Dolichandrone arcuata C.B. Cl.
Small tree in frs., rare.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35575.

Radermachera xylocarpa (Roxb.) K. Schum.
Tree with white fls. & frs., common.
Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35534; Kargudi, 950 m, 12-4-1972, *Vivekananthan* 40797.

Stereospermum angustifolium Haines
Small tree with purple fls. & frs., common.
Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40776.

S. personatum (Hassk.) Chatterjee
S. tetragonum DC.
Tree in frs., occasional.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35005.

Tecoma stans Juss.
Small tree with yellow fls., cultivated.
Benne-Devarshola, 1225 m, 21-1-1961, *Shetty* 11940.

Acanthaceae

Andrographis serpyllifolia (Vahl) Wt.
Procumbent herb with yellow fls., very common.
Theppakadu, 850 m, November 1884, *Gamble* 15414; Doddagatti, 900 m, 23-6-1970, *Shetty* 34364; Moyar R.F., 900 m, 18-8-1970, *Sharma* 35578 & 24-11-1971, *Rathakrishnan* 39004.

Asystasia chelonoides Nees var. *quadrangularis* C.B. Cl.
Shrub with purple fls., occasional.
Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35536.

Barleria buxifolia Linn.
Small shrub with pink fls., common.
Moyar R.F., 925 m, 21-4-1971, *Rathakrishnan* 38024 & 15-2-1972, *Sharma* 39802.

B. mysorensis Heyne
Shrub in frs., occasional.
Bokkapuram R.F., 1100 m, 13-8-1790, *Sharma* 35456.

B. prionitis Linn.
Undershrub with orange-yellow fls., occasional.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38989.

Crossandra infundibuliformis (Linn.) Nees
C. undulaefolia Salisb.
Shrub with orange-yellow fls., rare.
Moyar bank, 550 m, 16-2-1972, *Sharma* 39811.

Dicliptera cuneata Nees
Herb with pink fls., common.
Benne, 1125 m, 21-1-1960, *Shetty* 11951; Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35451.

Hygrophila salicifolia (Vahl) Nees
H. angustifolia auct. non R. Br.
Herb in frs., rare.
Benne, 1050 m, November 1884, *Gamble* 15609.

Justicia betonica Linn.
Shrub with white fls., occasional.
Benne, 1125 m, 21-1-1961, *Shetty* 11954.

Lepidagathis hyalina Nees
Herb with white fls., occasional.
Benne, 1140 m, 21-1-1961, *Shetty* 11943.

Nilgirianthus heyneanus (Nees) Bremek.
Strobilanthus heyneanus Nees
Shrub with pale blue fls., rare.
Benne, 1050 m, November 1884, *Gamble* 15619.

Peristrophe bicalyculata (Retz.) Nees
Herb with pink fls., occasional.
Masinagudi, 1000 m, November 1886, *Gamble* 18455.

Rostellularia diffusa (Willd.) Nees var. *orbiculata* (Wall. ex T. Anders.) Ellis
Justicia orbiculata Wall. ex T. Anders
Herb with purple fls., occasional.
Bokkapuram R.F., 1175 m, 14-8-1970, *Sharma* 35458.

R. pumila Nees
Justicia simplex D. Don
Herb with purple, fls., very common.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10469; Kargudi-Doddagatti, 900 m, 23-6-1970, *Shetty* 34378; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43062.

Thunbergia fragrans Roxb.
Twiner with white fls., occasional.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35377.

T. fragrans Roxb. var. *laevis* (Nees) C.B. Cl.
Twiner with white fls. & frs., occasional.
Benne R.F., 1050 m, 16-8-1960, *Subramanyam* 10400.

VERBENACEAE

Callicarpa tomentosa (Linn.) Murray
C. lanata Linn.
Large shrub with purple fls., occasional.
Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40780.

Clerodendrum serratum Moon
Shrub with blue fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10393; Doddagatti, 900 m, 23-6-1970, *Shetty* 34367.

C. viscosum Vent.
C. infortunatum auct. non Linn.
Large shrub with pinkish white fls. & frs., common.
Mudumalai-Gudalur, 1100 m, 20-7-1960, *Subramanyam* 10482.

Gmelina arborea Roxb.
Tree with yellow fls., occasional.
Moyar R.F., 550 m, 16-2-1972, *Sharma* 39816.

G. asiatica Linn.
Shrub with yellow fls., occasional.
Avarihalla R.F., 950 m, 20-2-1972, *Sharma* 39867.

Lantana indica Roxb.
Shrub with purple fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10401.

L. indica Roxb. var. *albiflora* Wt. ex C.B. Cl.
L. wightiana Wall.
Undershrub with white fls., occasional.
Moyar R.F., 925 m, 24-11-1971, *Rathakrishnan* 39001.

Premna tomentosa Willd.
Tree with greenish yellow fls. & frs., common.
Mudumalai, 1100 m, 1873, *Beddome* s.n. (MH 39826); Moyar R.F., 925 m, 21-4-1971, *Rathakrishnan* 38017; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40755.

Pygmaeopremna herbacea (Roxb.) Moldenke
Premna herbacea Roxb.
Herb with white fls., common.
Mudumalai, 1100 m, 1873, *Beddome* s.n. (MH 39870).

Tectona grandis Linn. f.
Tree in frs., common.
Masinagudi, 1000 m, November 1886, *Gamble* 18435.

Vitex altissima Linn. f.
Tree, fls., white, tinged with blue and in frs., common.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35725 & 19-4-1971, *Rathakrishnan* 37981.

V. leucoxylon Linn. f.
Tree with white fls., common.
Moyar bank, 550 m, 19-4-1971; *Rathakrishnan* 37983; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40742.

V. peduncularis Wall. ex Schauer
Tree with white fls., common.
Kargudi, 950 m, 12-4-1972, *Vivekananthan* 40805.

LABIATAE (LAMIACEAE)

Anisomeles indica (Linn.) O. Kuntze
Herb with purple fls., common.
Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43064.

Coleus forskohlii (Poir.) Briq.
C. barbatus Benth.
Herb with blue fls., occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35414.

Gomphostemma heyneanum Wall. ex Benth.
Shrub with yellow fls., very common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10384; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35501; Thorapalli-Kargudi, 850 m, 26-10-1972, *Vivekananthan* 43090.

Leucas hirta Spr.
Undershrub with white fls., very common.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10485; Doddagatti, 900 m, 23-6-1970, *Shetty* 34361; Avarihalla R.F., 950 m, 19-8-1970, *Sharma* 35616.

L. lavandulaefolia Rees
Herb with white fls., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35388; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43065.

L. marrubioides Desf.
Herb with white fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10388; Kargudi-Doddagatti, 900 m, 23-6-1970, *Shetty* 34376.

L. martinicensis R. Br.
Herb with white fls., common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrish-*

nan 38979; Kargudi, 975 m, 28-10-1972, *Vivekananthan* 43100.

Ocimum americanum Linn.
O. canum Sims.
Herb with white or purple fls., occasional.
Benne R.F., 950 m, 27-6-1970, *Shetty* 34424.

Orthosiphon glabratus Benth.
Herb with purple fls., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35570.

O. rubicundus Benth.
Herb with white fls., occasional.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34370; Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35538.

O. viscosus Benth.
Herb with pale purple fls., occasional.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10486; Moyar R.F., 925 m, 21-4-1971, *Rathakrishnan* 38019.

Plectranthus incanus Linn.
Herb with purple fls., common.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35504; Kargudi, 975 m, 29-10-1972, *Vivekananthan* 43103.

Pogostemon auricularia (Linn.) Massk.
Dysophylla auricularia Bl.
Herb with lilac fls., & frs., common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10446.

NYCTAGINACEAE

Boerhaavia chinensis (L.) Asch. & Sch.
Diffuse herb with pink fls. & frs., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35608; Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38988.

AMARANTHACEAE

Aerva lanata (Linn.) Juss.
Undershrub with greenish-white fls., common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35567.

Allmania nodiflora (Linn.) R. Br.
Herb with pink fls., occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35407.

Pupalia lappacea (Linn.) Juss.
Slender herb with greenish yellow fls., occasional.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35708.

POLYGONACEAE

Polygonum barbatum Linn.
Herb with white fls., common.
Theppakadu, 825 m, 24-6-1970, *Shetty* 34394.

P. glabrum Willd.
Herb with pink fls., very common.
Avarihalla R.F., 950 m, 18-8-1970, *Sharma* 35617; Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37963; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40745.

P. hydropiper Linn. var. *flaccidum* (Meissn.) Steud.
P. flaccidum Meissn.
Slender herb with pink fls., common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10443 & 27-6-1970, *Shetty* 34425; Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35454.

PIPERACEAE

Peperomia dindigulensis Miq.
Small succulent herb with yellow fls., common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35398 & 35426.

LAURACEAE

Litsea deccanensis Gamble
Small tree with greenish yellow fls., rare.
Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35449.

Persea gratissima Gaertn.
Small cultivated tree in fls. & frs.
Benne, 1225 m, 21-1-1961, *Shetty* 11939.

LORANTHACEAE

Dendrophthoe falcata (Linn. f.) Etting.
Loranthus longiflorus Desv.
Hemiparasitic on *Tectona grandis* with scarlet fls., occasional.
Mudumalai, 1100 m, November 1889, *Gamble* 15660.

Macrosolen parasiticus (Linn.) Danser
Elytranthe loniceroides Engle
Hemiparasitic shrub on *Anogeissus latifolia* with red fls., common.
Kargudi, 1000 m, 24-6-1970, *Shetty* 34396; Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35540.

Taxillus heyneanus (Schult.) Danser
Loranthus bracteatus Wall.
Hemiparasitic shrub with pale green fls., occasional.

Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37974.

T. tomentosus (Roth) Van Tiegh.
Loranthus tomentosus Roth
Hemiparasitic shrub, fls. greenish and rusty tomentose, occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35402.

Viscum angulatum Heyne ex DC.
Leafless parasitic shrub in frs., occasional.
Benne R.F., 850 m, 27-6-1970, *Shetty* 34430; Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35403.

V. articulatum Burm. f.
Leafless parasitic shrub on *Albizzia* sp. and *Zizyphus* sp. in frs., very common.
Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35437; Avarihalla R.f., 925 m, 21-4-1971, *Rathakrishnan* 38028.

V. capitellatum Sm.
Hemiparasitic shrub on *Dendrophthoe falcata* which is again parasitic on *Dalbergia* sp. in frs., rare.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35712.

V. heyneanum DC.
V. verruculosum Wt. & Arn. *V. orbiculatum* Wt.
Hemiparasitic shrub on *Phyllanthus* sp. with yellow fls. & frs., occasional.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35381.

V. orientale Willd.
Hemiparasitic shrub on *Ficus tomentosa* in frs., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35566.

V. trilobatum Talbot
Hemiparasitic shrub on *Dendrophthoe trigona* which in turn grows on *Ficus tinctoria* ssp. *parasitica* with greenish fls. & frs., rare.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35430.

SANTALACEAE

Santalum album Linn.
Small tree with red fls., common.
Kargudi, 1000 m, 24-6-1970, *Shetty* 34395; Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35383.

EUPHORBIACEAE

Acalypha fruticosa Forsk.
Shrub with pale green fls., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35572.

A. indica Linn.
Herb with pale green fls., common.
Avarihalla R.F., 950 m, 19-8-1970, *Sharma* 35614.

A. racemosa Heyne ex Baill.
A. paniculata Miq.
Undershrub with greenish yellow fls., occasional
Bokkapuram R.F., 1175 m, 14-8-1970, *Sharma* 35457.

Antidesma diadrum Roth
Shrub in frs., common.
Mudumalai, 1100 m, August 1886, *Gamble* 17876; Doddagatti, 900 m, 23-6-1970, *Shetty* 34352; Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35542.

Bridelia retusa (Linn) Spr.
Scandent shrub in frs., occasional.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35380.

B. roxburghiana (Hook. f.) Gehrm.
Tree in frs., occasional.
Kargudi, 1000 m, 24-6-1970, *Shetty* 34399; Singara R.F., 1050 m, 18-4-1971, *Rathakrishnan* 37955.

Croton oblongifolius Roxb.
Small tree with greenish yellow fls. & frs., rare.
Kargudi, 950 m, 12-4-1972, *Vivekananthan* 40803.

Drypetes roxburghii (Wall.) Airy Shaw
Putranjiva roxburghii Wall.
Medium-sized tree in frs., common.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35711 & 23-11-1971, *Rathakrishnan* 38992.

Euphorbia cristata Heyne ex Roth
Undershrub in fls., occasional.
Mudumalai, 1100 m, 24-6-1970, *Shetty* 34380.

E. hirta Linn.
Prostrate herb with greenish fls. & frs., common.
Kalhatti-Masinagudi, 1150 m, 23-8-1970, *Sharma* 35747.

E. hypericifolia Linn.
Herb with white fls. & frs., common.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10499; Kalhatti-Masinagudi, 1150 m, 23-8-1970, *Sharma* 35735.

E. nivulia Buch.-Ham.
Shrub in fls., occasional.
Moyar bank, 550 m, 16-2-1972, *Sharma* 39809.

Givotia rottleriformis Griff.
Tree with yellow fls. & frs., very common.
Bokkapuram R.F., 1000 m, 13-8-1970, *Sharma* 35440; Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37973; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40751; Mudumalai, 900 m, 11-4-1972, *Vivekananthan* 40794.

Glochidion velutinum Wt.
Small tree with yellow fls., occasional.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10476.

G. zeylanicum A. Juss.
Small tree with yellow fls. & frs., occasional.
Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40754.

Homonoia riparia Lour.
Rheophytic shrub in frs., occasional.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35717.

Jatropha heterophylla Heyne ex Hook. f.
Shrub with greenish fls. & frs., occasional.
Theppakadu, 850 m, August 1886, *Gamble* 17981; Mudumalai, 825 m, 24-6-1970, *Shetty* 34404.

Kirganelia reticulata (Poir.) Baill.
Straggling shrub with yellow fls., occasional.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35718.

Mallotus albus Muell.-Arg. var. *occidentalis* Hook.f.
Tree in fls. & frs., occasional.
Devarshola-Benne, 1260 m, 21-1-1961, *Shetty* 11937.

M. muricatus (Wt.) Mueller
Small tree with pale green fls., occasional.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35730.

M. philippensis (Lamk.) Muell.-Arg.
Small tree with pale green fls., occasional.
Kalhatti-Masinagudi, 1150 m, 23-8-1970, *Sharma* 35731.

Phyllanthus pinnatus (Wt.) Webster
Reidia floribunda Wt.
Herb with red fls., rare.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35395.

P. rheedii Wt.
Herb with greenish fls., common.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10473; Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35409.

P. virgatus Forst. f.
P. simplex Retz.
Herb in frs., occasional.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35599.

Securinega leucopyrus (Willd.) Muell.-Arg.
Fluggea leucopyrus Willd.
Straggling shrub with yellow frs., common.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35558.

S. virosa (Roxb. ex Willd.) Baillon
Fluggea virosa Baill.
Shrub with greenish yellow fls., common.
Benne R.F., 875 m, 10-4-1972, *Vivekananthan* 40771.

Tragia involucrata Linn.
Climbing herb with stinging bristles in frs., occasional.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35721.

ULMACEAE

Celtis cinnamomea Lindl. ex Planch.
Small tree in frs., occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35564.

MORACEAE

Ficus bengalensis Linn.
Tree in red syconia, occasional.
Bokkapuram, R.F., 1100 m, 13-8-1970, *Sharma* 35448.

F. hispida Linn. f.
Tree in yellow syconia, common.
Kargudi, 1000 m, 24-6-1970, *Shetty* 34398 & 12-4-1972 *Vivekananthan* 40795.

F. macrocarpa
F. retusa auct. non Linn.
Small tree in greenish syconia. Common.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37966; Theppakadu, 850 m, 9-4-1972, *Vivekananthan* 40763.

F. racemosa Linn.
F. glomerata Roxb.
Large tree in greenish syconia, occasional.
Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35455.

F. tomentosa Roxb.
Tree in grey tomentose syconia, rare.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35556.

URTICACEAE

Pouzolzia auriculata Wt.
Erect herb with white fls., rare.
Bokkapuram R.F., 1175 m, 14-8-1970, *Sharma* 35459.

Salicaceae

Salix tetrasperma Roxb.
Medium-sized tree near streams with yellow fls., rare.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38998.

MONOCOTYLEDONS

Orchidaceae

* *Habenaria furcifera* Lindl.
Terrestrial herb with greenish fls., common.
Mudumalai, 1100 m, 23-9-1928, *Narayana & Raju* 18327; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35513.

H. plantaginea Lindl.
Terrestrial herb with white fls., common.
Mudumalai, 1100 m, 23-9-1928, *Narayana & Raju* 18326 & 27-10-1972, *Vivekananthan* 43092; Moyar R.F., 925 m, 24-11-1971, *Rathakrishnan* 39005.

* *Liparis prazeri* King & Pantl.
Terrestrial herb with greenish fls., rare.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10460.

Nervilia aragoana Gaud.
Terrestrial herb with leaves (leaf appear after flowers), rare.
Birala-Thorapalli, 850 m, 26-10-1972, *Vivekananthan* 43089.

Peristylus goodyeroides (D. Don) Lindl.
Terrestrial herb with greenish yellow fls. & frs., very common.
Benne, 950 m, November 1884, *Gamble* 15607; Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10497 & 27-10-1972, *Vivekananthan* 43094.

* *P. lawii* Wt.
Terrestrial herb with white fls., rare.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34354.

Polystachya flavescens (Bl.) J.J. Sm.
P. wightii Reichb., *P. purpurea* Wt.
Epiphytic herb with brownish fls. & frs., common.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35514.

Vanda testacea (Lindl.) Reichb. f.
V. parviflora Lindl.
Epiphytic herb with yellow fls., common.
Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35452; Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37969; Kargudi, 875 m, 10-4-1972, *Vivekananthan* 40786.

Zingiberaceae

Costus speciosus (Koen.) J.E. Sm.
Herb with white fls., common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10452.

Globba bulbifera Roxb.
Herb with orange-yellow fls., common.
Benne R.F., 1050 m, 16-7-1970, *Subramanyam* 10385; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35502.

Hypoxidaceae

Curculigo orchioides Gaertn.
Herb with yellow fls., common.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10398; Doddagatti, 900 m, 23-6-1970, *Shetty* 34368; Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35431.

Agavaceae

Furcraea foetida (Linn.) Haw.
F. gigantea Vent.
Shrub with bulbils, common.
Bokkapuram R.F., 1100 m, 13-8-1970, *Sharma* 35453.

Dioscoreaceae

Dioscorea bulbifera Linn.
Climbing herb with greenish fls., occasional.
Thorapalli, 850 m, 26-10-1972, *Vivekananthan* 43082.

D. hispida Dennst.
Climbing herb in fls. & frs.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10488; Benne R.F., 950 m, 27-6-1970, *Shetty* 34421,

D. oppositifolia Linn.
Climbing herb with greenish fls., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35581; Kargudi, 850 m, 26-10-1972, *Vivekananthan* 43078.

D. pentaphylla Linn. var. *linnaei* Prain & Burkill
Climbing herb in buds, occasional.
Benne R.F., 950 m, 27-6-1970, *Shetty* 34423.

D. tomentosa Koen. ex Spreng.
Climbing herb with greenish yellow fls., common.
Benne R.F., 850 m, 27-6-1970, *Shetty* 34435; Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35528; Birala-Thorapalli, 850 m, 26-10-1972, *Vivekananthan* 43081.

SMILACACEAE

Smilax perfoliata Lour.
S. prolifera Roxb.
Climbing shrub in frs., common.
Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35546.

LILIACEAE

Asparagus racemosus Willd.
Climbing undershrub with white fls. & frs., common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35398.

Chlorophytum tuberosum (Roxb.) Baker
Herb with white fls. & frs., common.
Mudumalai, 1100 m, 20-9-1960, *Subramanyam* 10489; Doddagatti, 900 m, 23-6-1970, *Shetty* 34372.

Gloriosa superba Linn.
Climbing herb with red-yellow fls., occasional.
Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10395.

PONTEDERIACEAE

Monochoria vaginalis (Burm. f.) Presl
Herb in marshy places with blue fls. & frs., occasional.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10445.

COMMELINACEAE

Commelina undulata R. Br.
C. kurzii C.B. Cl.
Herb with blue fls., common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35592; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35498.

Cyanotis cristata (Linn.) D. Don
Herb with blue fls., very common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10453; Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35432 & 14-8-1970, *Sharma* 35463.

Murdannia elata (Vahl) Brueckn.
Aneilema lineolatum Kunth
Herb with blue fls. & frs., occasional.
Benne R.F., 1050 m, 16-7-1960, *Shetty* 10382.

M. simplex (Vahl) Brenan
Aneilema sinicum Lindl.
Herb with blue fls. & frs., common.
Benne, 950 m, November 1884, *Gamble* 15676 & 18-7-1960, *Subramanyam* 10472.

M. spirata (Linn.) Brueckn.
Aneilema spiratum R. Br.
Herb with blue fls. & frs., occasional.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10454.

M. zeylanica (C.B. Cl.) Brueckn. var. *longicapsa* (C.B. Cl.) Rolla Rao & Kammathy
Aneilema zeylanicum C.B. Cl. var. *longicapsa* C.B. Cl.
Herb with white fls. & frs., common.
Moyar, 950 m, 3-10-1956, *Balakrishnan* 202; Benne R.F., 1050 m, 16-7-1960, *Subramanyam* 10381.

ARACEAE

Arisaema tortuosum (Wall.) Schott
Herb, spathe greenish and spadix yellowish, rare.
Benne, R.F., 1050 m, 16-7-1960, *Subramanyam* 10390.

Colocasia esculenta (Linn.) Schott
C. antiquorum Schott
Herb, spathe pale yellowish, rare.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10451.

ERIOCAULACEAE

Eriocaulon quinquangulare Linn.
Herb with white heads, rare.
Benne, 1125 m, 21-1-1960, *Shetty* 11953.

CYPERACEAE

Carex speciosa Kunth
Slender sedge, rare.
Theppakadu, 850 m, November 1889, *Lawson* s.n. (MH 53946).

Cyperus cyperinus (Retz.) Valck.-Sur.
Mariscus cyperinus Vahl
Erect sedge with short rhizome in brownish nuts, occasional.
Mudumalai, 850 m, 23-9-1928, *Narayana & Raju* 18315.

C. cyperioides (Linn.) O. Ktze.
Mariscus sieberianus Nees
Sedge with creeping rhizome in blackish nuts, common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10438.

C. distans Linn. f.
Robust perennial sedge with stoloniferous rhizome in brownish nuts, common.
Benne R.F., 1050 m, 16-7-1970, *Subramanyam* 10388.

C. dubius Rottb.
Mariscus dubius Kukenth. ex C.E.C. Fischer
Erect sedge with solitary head in blackish nuts, occasional.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35411.

C. iria Linn.
Sedge with triquetrous stem in blackish nuts, rare.
Theppakadu, 850 m, August 1886, *Lawson* s.n. (MH 53255).

C. kyllingia Endl.
Kyllinga monocephala Rottb.
Sedge with elongated rhizome in damp places, nuts yellowish brown, common.
Benne, 1200 m, 19-7-1960, *Subramanyam* 10465; Theppakadu, 850 m, 25-10-1972, *Vivekananthan* 43058.

C. melanospermus (Nees) Valck.-Sur.
Kyllinga melanosperma Nees
Sedge with horizontal rhizome in moist places, nuts blackish, common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35425.

C. paniceus (Rottb.) Boeck.
Mariscus paniceus Vahl
Erect sedge in pale brownish nuts, occasional.
Bokkapuram R.F., 1250 m, 14-8-1970, *Sharma* 35462.

C. teneriffae Poir.
Sedge in rock crevices, nuts dark brownish, rare.
Moyar dam, 900 m, 17-8-1970, *Sharma* 35563.

C. tenuicalmis Boeck.
C. zollingeri auct. non Steud.
Sedge in moist places, occasional.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10441.

Fimbristylis complanata (Retz.) Link
Sedge in moist places, nuts white, occasional.
Moyar R.F., 900 m, 17-8-1970, *Sharma* 35561.

Scleria hebecarpa Nees
Perennial sedge with woody rhizome in white or brownish nuts, common.
Benne, 1000 m, 1817-1960, *Subramanyam* 10459; Doddagatti, 900 m, 23-6-1970, *Shetty* 34350.

GRAMINEAE (POACEAE)

Alloteropsis cimicina (Linn.) Stapf
Annual erect grass, rare.
Theppakadu, 850 m, August 1886, *Lawson* s.n. (MH 55182).

Aristida depressa Retz.
Annual grass, common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrish-* 38908.

Arundinella leptochloa (Nees ex Steud.) Hook. f.
Perennial grass, common.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10479.

Bothriochloa pertusa (Linn.) A. Camus
Amphilophis pertusa (Linn.) Nash ex Stapf
Perennial grass, common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan* 38913.

Brachiaria eruciformis (J. E. Sm.) Griseb.
Annual grass growing in tufts, rare.
Masinagudi, 1000 m, 12-5-1900, *Barber* 2599.

B. ramosa (Linn.) Stapf
Annual grass, rare.
Theppakadu, 850 m, November 1889, *Lawson* s.n. (MH 54764).

Centotheca lappacea (Linn.) Desv.
Perennial grass, rare.
Benne, 1000 m, November 1886, *Gamble* 18347.

Chloris dolichostachya Lagasca
C. incompleta (Roth) Chiov.
Perennial tufted grass, very common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrish-nan* 38921.

Chrysopogon aciculatus (Retz.) Trin.
Perennial grass in open grasslands, common.
Benne, R.F., 850 m, 27-6-1970, *Shetty* 34429.

C. zeylanicus (Nees) Thw.
Large tufted grass, common.
Avarihalla R.F., 910 m, 20-11-1971, *Rathakrishnan nan* 38915.

Cymbopogon flexuosus (Nees ex Steud.) Wats.
Perennial grass (popularly known as lemon grass) in open grasslands, common.
Kargudi, 975 m, 29-10-1972, *Vivekananthan* 43109.

C. nardus (Linn.) Rendle
Probably the grass cultivated for its aromatic oil.
Mudumalai, 1100 m, *Beddome* s.n. (MH 88444).

Cynodon arcuatus J. S. Presl ex C.B. Presl
C. dactylon Pers. var. *intermedius* C.E.C. Fischer
Perennial, creeping grass, common.

Theppakadu, 850 m, November 1889, *Lawson* s.n. (MH 88727).

Dactyloctenium aegyptium (Linn.) P. Beauv.
Erect or decumbent annual grass, rare.
Masinagudi, 1000 m, November 1886, *Gamble* 18442.

Digitaria ciliaris (Retz.) Koel.
D. marginata Link
Erect or decumbent annual grass, very common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10449; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35519

Eragrostiella bifaria (Vahl) Bor
Eragrostis bifaria Wt. ex Steud.
Perennial, densely tufted grass, very common.
Mudumalai, 900 m, 24-6-1970, *Shetty* 34383; Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35525.

Eragrostis cilianensis (All.) Vignolo-Lutati
Annual, tufted grass, very common.
Masinagudi, 1000 m, April 1900, *Barber* 2667; Kalhatti-Masinagudi, 1150 m, 23-8-1970, *Sharma* 35739.

E. unioloides (Retz.) Nees ex Steud.
Annual, tufted grass, common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35427.

Hackelochloa granularis (Linn.) O. Ktze.
Annual grass, common.
Mudumalai, 900 m, 24-6-1970, *Shetty* 34382.

Heteropogon contortus (Linn.) P. Beauv.
Perennial gregarious grass in open grasslands, common.
Kargudi, 975 m, 29-10-1972, *Vivekananthan,* 43104.

Imperata cylindrica (Linn.) P. Beauv. var. *major* (Nees) C.E. Hubb.
I. cylindrica var. *koenigii* (Retz.) Dur. & Schinz.
Perennial erect grass with creeping rhizome, very common.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10498; Benne R.F., 950 m, 27-6-1970, *Shetty* 34422.

Leptochloa obtusiflora Hochst.
Annual slender grass, rare.
Masinagudi, 1000 m, May 1900, *Barber* 2556.

Oryza meyeriana (Zoll & Mor. ex Steud.) Baill. ssp. *granulata* (Nees & Arn. ex Watt) Tateoka.
O. meyeriana Baill.
Annual, slender grass in marshy places, rare.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35511.

Panicum notatum Retz.
P. montanum Roxb.
Perennial grass, rare.
Theppakadu, 850 m, November 1889, *Lawson* s.n. (MH 55042).

Paspalidium flavidum (Retz.) A. Camus
Perennial grass, common.
Mudumalai, 1100 m, 20-7-1960, *Subramanyam* 10496; Doddagatti, 900 m, 23-6-1970, *Shetty* 34348.

Paspalum conjugatum Berg.
Annual, slender grass, common.
Benne, 1200 m, 19-7-1960, *Subramanyam* 10464.

P. scrobiculatum Linn.
Annual grass. The grain is used for food as a substitute of rice in some Southern districts.
Masinagudi, 1000 m, 10-5-1900, *Barber* 2590.

Pennisetum hohenackeri Hochst. ex Steud.
Perennial, densely tufted grass, rare.
Masinagudi, 1000 m, September 1900, *Barber* 2615.

Perotis indica (Linn.) D. Ktze.
Tufted grass, common.
Northern Hay R.F., 950 m, 16-8-1970, *Sharma* 35526.

Pogonatherum paniceum (Lamk.) Hack.
Slender grass, common.
Moyar bank, 550 m, 19-4-1971, *Rathakrishnan* 37967.

Setaria pallidefusca (Schum.) Stapf et C.E. Hubb.
Annual tufted grass, very common.
Mudumalai, 900 m, 24-6-1970, *Shetty* 34379; Moyar R.F., 900 m, 18-8-1970, *Sharma* 35590.

S. palmifolia (Koen.) Stapf
Perennial grass, common.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35516.

S. tomentosa (Roxb.) Kunth
S. intermedia Roem. & Schult.
Annual grass, common.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35494.

S. verticillata (Linn.) P. Beauv.
Annual grass in shady and damp places, common.
Kalhatti-Masinagudi, 1150 m, 23-8-1970, *Sharma* 35746.

Sorghum halepense (Linn.) Pers.
Perennial grass near streams, common.
Moyar bank, 525 m, 23-11-1971, *Rathakrishnan* 38987.

S. nitidum (Vahl) Pers.
Tufted grass, rare.
Mudumalai, 1100 m, 23-9-1928, *Narayana & Raju* 18324.

Sporobolus fertilis (Steud.) W. D. Clayton
S. indicus acut. (non Linn.)
Perennial grass, common.
Mudumalai, 1100 m, *Beddome* s.n. (MH 88662); Benne, 1000 m, 19-7-1960, *Subramanyam* 10470.

S. wallichi Munro ex Trin.
Erect grass, rare.
Theppakadu, 850 m, November 1889, *Lawson* s.n. (MH 57399).

Themeda cymbaria Hack.
Perennial robust grass, common.
Mudumalai, 1100 m, 23-9-1928, *Narayana & Raju* 18323 & 20-7-1960, *Subramanyam* 10495.

T. quadrivalvis (Linn.) O. Ktze.
Annual, robust grass in open grasslands; common.
Kargudi, 975 m, 29-10-1972, *Vivekananthan* 43106.

T. triandra Forssk.
Perennial, erect grass in grasslands, very common.
Mudumalai, 1100 m, 23-9-1928, *Narayana & Raju* 18322 & 20-7-1960, *Subramanyam* 10491; Kargudi, 975 m, 29-10-1972, *Vivekananthan* 43108.

Tragus biflorus Schult.
Perennial grass, common.
Theppakadu, 850 m, August 1886, *Lawson* s.n. (MH 88644).

Tripogon wightii Hook. f.
Slender grass, common.
Masinagudi, 1000 m, April 1900, *Barber* 2653.

Urochloa panicoides P. Beauv.
Annual grass, common.
Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35518.

FERNS

OPHIOGLOSSACEAE

Ophioglossum reticulatum Linn.
Small fern in humus soil or marshy places with sporangial spike, very common.
Moyar 950 m, 3-10-1956, *Balakrishnan* 204; Benne, 1200 m, 19-7-1960, *Subramanyam* 10462; Birala-Thorapalli, 850 m, 26-10-1972, *Vivekananthan* 43076.

SCHIZAEACEAE

Lygodium flexuosum (Linn.) Sw.
Climbing fern in sporangia, common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10458.

ADIANTACEAE

Adiantum caudatum Linn.
Small tufted fern on rocky crevices in sori, common.
Bokkapuram R.F., 1100 m, 12-8-1970, *Sharma* 35412.

A. falcatum Linn.
Small fern in sori, rare.
Moyar, 950 m, 3-10-1956, *Balakrishnan* 179.

A. philippense Linn.
A. lunulatum Burm. f.
Small tufted fern in marshy places, sori marginal.
Doddagatti, 900 m, 23-6-1970, *Shetty* 34377; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35506.

HEMIONITIDACEAE

Hemionitis arifolia (Burm. f.) Moore
Small fern with hastate fronds in sori, rare.
Bokkapuram R.F., 1250 m, 14-8-1970, *Sharma* 35464.

ACTINIOPTERIDACEAE

Actiniopteris radiata (Sw.) Link
A. dichotoma Forsk.
Small fern usually found on rocky crevices in marginal sori, very common.
Moyar R.F., 900 m, 18-8-1970, *Sharma* 35610; Moyar bank, 600 m, 19-4-1971, *Rathakrishnan* 37972.

SINOPTERIDACEAE

Cheilanthes mysurensis Wall. ex. Hook.
Small fern on rocky crevices in sori, common.
Moyar bank, 550 m, 22-8-1970, *Sharma* 35726.

Pellaea geraniaefolia Fee
P. concolor Lang. & Fischer
Fern in moist or shady places in sori.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35393; Northern Hay R.F., 1000 m, 16-8-1970, *Sharma* 35532.

DAVALLIACEAE

Nephrolepis cordifolia (Linn.) Presl
N. tuberosa (Bory ex Willd.) Presl
Tufted fern in moist places, in sori.
Benne, 1000 m, 19-7-1960, *Subramanyam* 10471.

ATHYRIACEAE

Athyrium hohenackerianum (Kunze) Moore
Tufted fern, in sori, common.
Benne, 1000 m, 18-7-1960, *Subramanyam* 10439.

THELYPTERIDACEAE

Cyclosorus dentatus (Forsk.) Ching
Nephrodium molle Desv.
Tufted fern with oblong-lanceolate fronds, in sori, common.
Bokkapuram R.F., 1025 m, 12-8-1970, *Sharma* 35396.

POLYPODIACEAE

Drynaria quercifolia Linn.
Fern on rocky crevices or debris collected on tree-trunks, in sori, very common.
Benne, 1200 m, 19-7-1960, *Subramanyam* 10466; Northern Hay R.F., 950 m, 15-8-1970, *Sharma* 35507.

Microsorium membranaceum (D. Don) Ching
Pleopeltis membranacea Wall.
Fern with short creeping rhizome, in sori, rare.
Moyar, 950 m, 3-10-1956, *Balakrishnan* 193.

M. punctatum (Linn.) Copel.
Pleopeltis irioides Moore
P. punctata (Linn.) Bedd.
Fern with scarcely creeping rhizome, in sori, common.
Benne R.F., 850 m, 27-6-1970, *Shetty* 34431.

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A PRELIMINARY SURVEY OF THE SALTWATER CROCODILE (*CROCODYLUS POROSUS*) IN THE ANDAMAN ISLANDS[1]

R. Whitaker and Z. Whitaker

(*With five plates*)

During April, 1975 and May-August, 1976, survey trips were made to most of the major freshwater streams and associated tidal creeks on the east of South, Middle Andaman and North Andaman, part of the west of North Andaman, and some of the outlying islands. Crocodiles were found to be much depleted compared to earlier reports, mainly due to hunting in the past and now due to human settlements on almost all the fresh water streams and the associated requisite nesting habitat of *C. porosus*. Besides intensive human pressure, nests of *C. porosus* are susceptible to flooding and predation, especially by the Water Monitor Lizard (*Varanus salvator*) which is common in the islands.

The junior author, accompanied by an Irula snake catcher, arrived in Port Blair on 20th March 1975. She proceeded to North Andaman and spent 25 days seeing habitats in which crocodiles were reportedly once plentiful. The following is a brief account of her survey.

Date	Place	Findings, Remarks
22-3-75	Port Blair	Interviewed local officials in Forest and other departments, local residents. Crocodiles scarce in South Andaman. Used to be a fairly regular flow of skins through Port Blair to the mainland; no statistics available.
23, 24-3-75	South Andamans	Interviewed local settlers. Two kinds of crocodiles reported one light yellow and one dark species. Reports of crocodile attacks on man in Middle and North Andaman; very rare now. During early settlements (early 1950's), average of one or two people killed a year in northern area.
28-3-75	Aerial Bay, North Andaman	Interviewed local Forest Officers and met local crocodile hunter Kesavan. Measured skull of crocodile 94 × 42 cm said to have measured 21 ft.
29-3-75	Aerial Bay	For next few days visited mangrove creeks running inland from Aerial Bay. Tracks of several crocodiles seen in less travelled creeks.

[1]Accepted September 1977.

Date	Place	Findings, Remarks
3-4-75	Mayabandar	Interviewed local residents; crocodiles killed off in Austen Creek several years back.
5-4-75	Kalighat	Saw large 4-5 metre crocodile in main creek near Kalighat jetty.
6, 12-4-75	Mayabandar Panighat Webe Lucknow	Interviewed Karens and others; crocodile hunting and hooking techniques described. Formerly speared (detachable head type), now mainly caught on baited hooks left overnight with large conspicuous buoy attached. Followed up and pulled out next day, crocodile despatched with axe blow to head.
13-4-75	Rangat, Middle Andaman	Interviewed local settlers; crocodiles scarce since days of first settlements (early 50's).
14-4-75	Port Blair, surrounding mangrove swamps, Bamboo Flat etc.	Crocodiles still sporadically seen in creeks off Shoal Bay. Level of disturbance extreme on much of South Andaman.

In June 1976, the senior author arrived in Port Blair and spent the following 20 days in crocodile habitat mainly in North Andaman. He was accompanied by Mr. Ashok Sinha, ACF, for part of the trip and by Mr. Allen Vaughan for the whole trip.

The following is a brief account of his survey:

Date	Place visited	Mode of transport	*Findings, Remarks*
3-6-76	Arrived Aerial Bay, visited Mugger Nullah and Bazaar	Walk	Met several (ex) crocodile hunters and egg collectors. One hunter said to have killed nearly a thousand. Crocodiles scarce now.
4-6-76	Durgapur, Shivpur	Walk	Saw habitat, interviewed settlers. Few crocodiles in the Shivpur creek.
5-6-76	Smith Island, Gandhi-Nagar in Aerial Bay	Launch, Walk	Saw major creeks, interviewed forest labour and settlers. Crocodiles scarce but feared by the timber raft workers. Extensive clearing and disturbance in potential nesting areas as settlers collect cane, bamboo and palm fronds for construction.
6-6-76	Two largest creeks in Aerial Bay	Dugout, Walk	Saw nesting habitat restricted to upper stream, now settled and farmed; most perennial streams in North Andaman (except extreme north) have been settled upon.
	Diglipur market	Walk	Crocodile eggs on sale at Rs. 1/- each.
7-6-76	Badaltikeri	Launch, Walk	Accompanied N. A. Ranger, Mr. Mukhopadhya to seize a crocodile skin and fat from forest labour.
8-6-76	Manjunullah (Cadell Bay)	Launch, Walk	Made camp and visited nearby creeks.
9-6-76	Creeks of Cadell Bay	Dugout, Walk	Searched for suitable nesting habitat which is scarce. Saw one 4 m crocodile near camp.

Date	Place visited	Mode of transport	Findings, Remarks
10-6-76	Creeks North of Cadell Bay return to Aerial Bay	Dugout, Walk	Found 2 crocodile skulls and bones at hunters camp site. Little nesting habitat, no evidence of crocodiles.
11-6-76	Kalipur and down Shivpur creek	Walk, Dugout	Saw fresh tracks of five crocodiles in 5 km of creeks. No nesting habitat.
12-6-76	Mangrove and cane fringes in Aerial Bay	Walk	Saw 2 old nests but no other sign of crocodiles.
13-6-76	Laxmipur, Milangram, Swarajgram, Radhanagar, Shamnagar	Walk	Interviewed settlers, saw good crocodile nesting habitat; reportedly, most crocodiles killed several years back. New clearing in progress, crocodile encounters expected.
	Parseemsagar (West coast)	Walk, Dugout	Night visits to creeks, three crocodiles seen. Reports of plenty of crocodile killing in past.
14-6-76	Creeks near Shamnagar (RW)	Walk	Suitable nesting habitat, no signs of crocodiles. Extensive settlement and clearing.
	Creeks near Parseemsagar (AV)	Walk	Extensive rice cultivation in best habitat, no sign of crocodiles by day.
15-6-76	Mayabandar, nearby mangroves	Ferry, Walk	Crocodiles finished off in the Mayabandar area several years ago. Extensive settlement, creek traffic.
16-6-76	Parangara, Kishorinagar	Ferry, Walk	Walked through mangrove and grass habitat on settlement edge. Located 2 old nests and one intact nest of 51 eggs. Interviewed settlers.
17-6-76	Kishorinagar and surrdounding area	Walk	Good nesting habitat near settlement but much disturbance and crocodiles scarce now. One old nest and crocodile bones seen.
18-6-76	Kalighat	Walk	Interviewed settlers, saw some good habitat but much disturbed. One crocodile regularly seen in main creek near jetty (ZW '75).
19-6-76	Mayabandar, Port Blair	Ferry	In South Andaman R. Whitaker visited Chidiatapu, Bamboo Flat, Wimberleyganj and other nearby areas, interviewing settlers and forest department staff. Reports of crocodile scarcity in Andamans. Most experienced people confirm that Little Andaman and some parts of the Nicobars still have fairly intact crocodile populations.

We feel that unless survey work in more inaccessible parts of N. Andaman turns up a small protected breeding group, Andamans can be considered to have a very scattered crocodile population breeding sporadically. Shivpur Creek near Diglipur, was observed to have the largest adult population but no nesting habitat. Most perennial streams in North Andaman, East coast of Middle and South Andaman have been settled upon. Optimum crocodile nesting habitat and juveniles (intolerant to saltwater) optimum habitat is analogous to paddy land (i.e. flat stream drainage area just prior to the brackish water level). This steady (and continuing) loss of habitat formerly resulted in crocodiles being killed or moving to more remote (and perhaps less suitable) areas. Crocodiles are reported on several of the smaller offshore islands including North Reef (now a sanctuary), Land-

fall and parts of Ritchie's Archipelago. If these areas are assessed to be suitable (nesting habitat, prey, freedom from disturbance and, most important, fresh water), they may provide possible reserves for *C. porosus*.

Visits by the senior author in June-July 1977 to larger islands such as Interview Island, Smith Island, Sound Island, Anderson Island in North Andaman, Rutland and Labyrinth Islands in South Andaman yielded no evidence of crocodiles. Interviews with police outpost personnel, inter-island boat captains, crew and others concerning Cinque Islands, South Sentinel Island, Narcondam Island and Barren Island (the last three now sanctuaries) confirms there are no crocodiles on these either. Jackson Creek on the west coast of Little Andaman is reported to have a fair crocodile population. The East Coast of this Onge island is now suffering from intensive clearance and settlement developments.

The Nicobar Islands are still inadequately surveyed faunistically. In interviews with Police Wireless operators formerly posted there, plus inter-island ship captains we were able to confirm the presence of crocodiles on Teressa, Bompoka, Comorta, Trincat, Kachal, Nancowri, Little Nicobar and Great Nicobar. Older reports describe seeing occasional crocodiles on Car Nicobar, it is not known whether Tilanchong or Chowra have any. Nicobarese (in southern islands in particular) reportedly kill crocodiles occasionally to eat but no systematic hide hunting has ever been carried out in this group. Reports from Campbell Bay on Great Nicobar where clearance and settlement of primeval forest is now being intensified show the same pattern of events that led to the drastic decline of *C. porosus* in North Andaman. A letter from Mr. Humayun Abdulali (1977), who has been leading Bombay Natural History Society Expeditions to the Islands since 1964, confirms this. The large freshwater streams of the 600 sq km Great Nicobar: Galathea River, Alexandra River and Dagmar River are said to contain crocodile populations. These areas are so far mostly unsettled and are inhabited by the small scattered tribe called Shompen. Considering the reported relative lack of commercially valuable trees on Great Nicobar (Bonington, A & N Census, 1931) the presence of a healthy crocodile population points to forestry efforts toward management of crocodiles for revenue earning. The precedent has been set in Orissa, Rajasthan and Uttar Pradesh with major Forest Department crocodilian projects resulting from the FAO/UNDP programme under the consultancy of Dr. H. R. Bustard, at present in India. At this time it would be most valuable to undertake a complete, well supervised survey of the crocodile resources of the Nicobars. The senior author returned to Madras end June. From early July till late August Allen Vaughan visited areas in Middle Andamans not visited by the authors.

Vaughan feels the main crocodile nesting area left in the main islands (besides the Jarawa Reserve) is the Kalighat-Parangara area including the creeks near Stewart I. In 1977 four nests were reported from one, remote creek there. (For Vaughan's report see p. 48).

Other Notes:

One of the oldest extensive descriptions of the Bay Islands is a Government of India (Home Department) publication "The Andaman Islands", published in 1859. Reporting on the animal life it states: "The reptiles are snakes (several species), lizards, iguanas, tortoises and turtles". No mention is made of crocodiles. In 1863 Dr. F. J. Mouat published his book "The Andaman Islanders" and in a fauna list states "Of the crocodile group, so

far as I can learn, no species has been observed". The 1908 Local Gazetteer describes the Islands in detail but again no mention of crocodiles (though the abundance of sea turtles is stated). A letter from a Moravian missionary in the Nicobars in 1813 gives the first description of crocodiles in the Nicobars; this reference was evidently not seen by later authors: "Crocodiles are very numerous, wherever there are water, lakes and streams. They are of two kinds, the black kayman and the proper crocodile the former which is smaller, is fierce and rapacious; the latter is said never to attack any living creatures, but only to devour carrion".

In 1870, Dr. F. Stoliczka of the Geographical Survey of India states "There is no doubt of the occurrence of a crocodile on the Nicobars". Only in the Census report of 1931 is the question of crocodiles in the Bay Islands satisfactorily presented: "Some authorities have disputed the presence of crocodiles in the Andamans. They are common in the Andamans and also in the Nicobar but they are not found everywhere. They breed in the Diglipur stream of Port Cornwallis, where they are common, and in Jackson Creek of Little Andamans". Oddly, M. A. Smith, in a 1941 paper "The Herpetology of the Andaman and Nicobar Islands" lists crocodiles as being found in the Nicobars but not in the Andamans.

Later, in 1960 the author Suresh Vaidya wrote: "In calling at Port Cornwallis we had a special objective in view: We wanted to shoot crocodiles in the Diglipur Creek, the place was said to crawl with these creatures." and "The crocodiles have become wary since these Bengali farmers started trapping them. They sell the skins". In his book on the Nicobars, K. K. Mathur in 1976 wrote "The rivers of Great Nicobar are full of crocodiles".

Conclusion

Crocodiles were once abundant in most of the major streams and creeks in the Andamans. Since they must drink fresh water, and the young probably cannot survive in highly salty water and since optimum nesting (tall grass, cane and bamboo fringe) is usually in the transition swampy areas above the brackish mangrove fringe the crocodiles were always associated with these fresh water sources. There are few large perennial freshwater streams in the Andamans and all (with the exception of the Jarawa area) have been settled or illegally encroached upon. During the time of legalized crocodile hunting (prior to 1972) interaction between man and crocodile at the freshwater streams resulted in crocodile hunters getting every help and encouragement from settlers to whom the crocodile was (and is) looked upon as a nuisance.

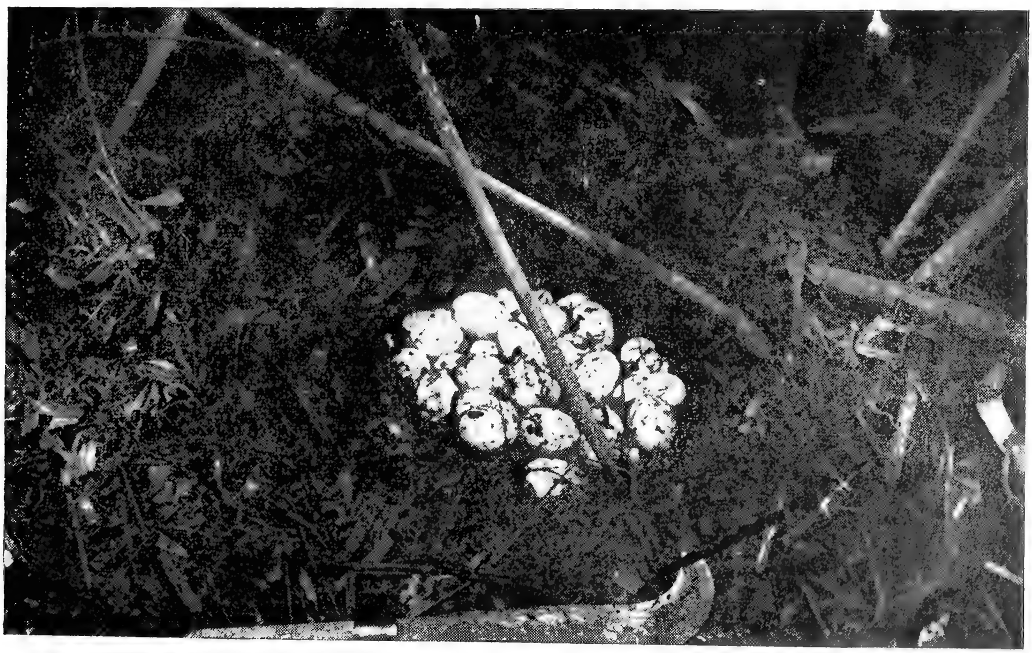
There are, unfortunately, few Forest Department protection staff for the large and difficult area to be protected and some crocodile killing and egg eating still prevails. Eggs now fetch upward of Re. 1/- each, fat Rs. 80/- to Rs. 100/- per kg. and single gall bladder Rs. 100/-. Crocodile skin sells anywhere from Rs. 10/- to Rs. 40/- per inch of belly width. In talks with local tradesmen, we understood that dealing in skins has all but ceased from fear of the new laws; dealing in fat and gall bladder continues on a small scale. The enforcement of the Wildlife Act has been well publicized in the Islands where news spreads fast. It may take several stiffly fined example cases before the protective laws can be fully implemented. During a visit in June, 1977, the senior author heard several reports of crocodiles regularly seen on routine ferry runs indicating better protection. The Forest Department Zoo in Port Blair is rearing 5 crocodiles in a new enclosure.

The following are the notes of Vaughan's trip:

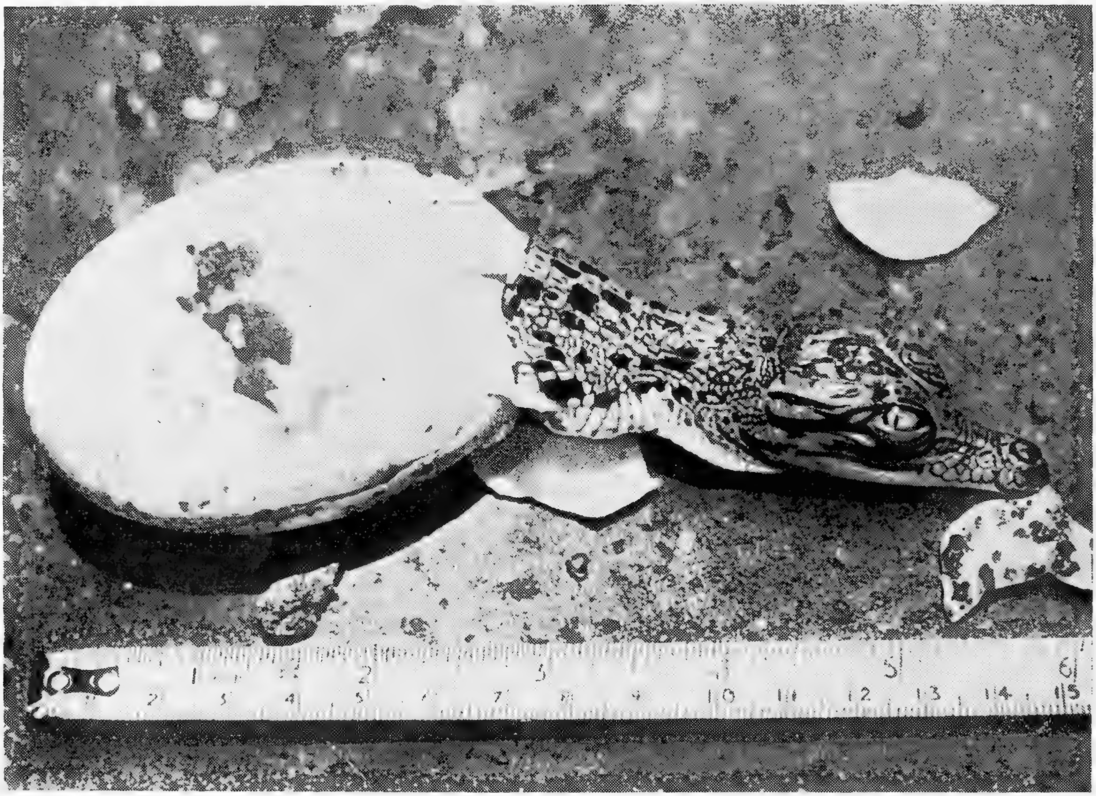
Place visited	Mode of transport	*Findings, Remarks*
CFO Nullah joins Betapur creek	Boat	One crocodile reported in each nullah; large fresh water plains sown with paddy.
Betapur creek	Boat, Walk	One crocodile seen (3-4 m).
Eratha, Bhakuntala creek, Lal tikri Shubri creek	Boat	Heavy disturbance—Jai Shree Plywood Company. Tracks of three crocodiles seen. One big crocodile 4-5 metres reported by fisherman.
Borumbali creek Borneo creek Parlogi creek	Boat	Border of Jarawa Reserve—good crocodile population reported here; investigator was not allowed access.
Long Island, Bomlungta	Boat	Good mangrove, no sign of crocodiles in day survey and interviewing.
Long Island	Boat	No mangrove—sandy.
Elphinstone harbour	Boat	Good mangrove, but heavy logging activity.
Papitadera	Boat, Walk	Good mangrove habitat; few crocodiles, one big one (5 m) reported.
Kadamtulla, Uthra Jetty Atargic Creek	Boat	Border of Jarawa reserve. Trespassing hunters and fisherman report good crocodile population in Reserve.
Baratang	Boat	Saw one crocodile at Khoda Khari, good mangrove, many small creeks; main boat route, few crocodiles.
Port Blair	Ferry	Interviewed old residents.
Mayabandar	Ferry, Walk	Interviewed ex-crocodile hunters, all concur that crocodiles becoming rare except in the Jarawa Reserve.
Kalighat	Boat	One 4 m crocodile reported regularly in main creek.
Ramnagar (east coast, North Andaman)	Walk	One crocodile killed 3 years back, none seen since then. Small creek, no crocodiles.
Kalara Creek-settlement	Walk	Found freshly robbed (by man) crocodile nest in cane near settlement. Very few nesting crocodiles now according to recent settlers.
Mayabandar	Walk	———
Kishorenagar (Parangara)	Ferry, Walk	No crocodiles or nests seen.
Kalighat-Mayabandar	Ferry	No crocodiles or nests reported.
Creek on Kalighat Parangara route	Walk and Boat	3 hatched nests, one full nest found in cane clumps, female nearby. 72 eggs, observed successful hatching some days later.
Karmatang No. 9	Boat, Walk	Good mangrove. young crocodile seen recently; much settlement activity.
Austen Creek, 1, 2, 3, 4	Boat	Many settlements, boating activity. Good crocodile habitat but close to Mayabandar. Crocodiles cleaned up long ago.
Stewart I, Rahill I and Khoda Khari	Boat	Good crocodile habitat, vast mangrove, good nesting areas. Too near Mayabandar so crocodiles very scarce.
Burong Creek	Boat	One crocodile reported recently killed on nest and eggs robbed.

Above: Skull at Diglipur from a *C. porosus* 5 m in length. *Below*: Mangrove lined creek in North Andaman.

Above: Mugger Nullah a large freshwater stream near Diglipur was once the best spot for crocodiles. It is now mainly cleaned and framed. *Below*: Remains of an old crocodile nest at Parangara (North Andaman) in the cane and palm fringe above the mangrove.

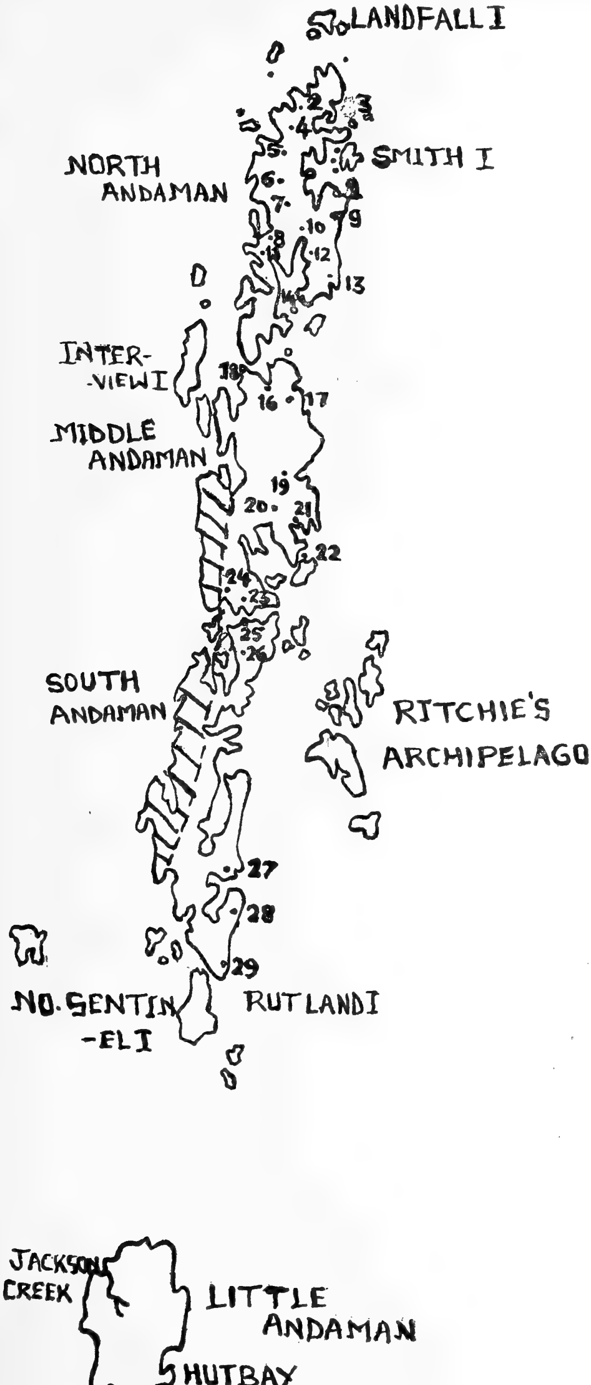


Above: Intact nest of a 3 m *C. porosus*. The parent crocodile was hidden in bushes in the dark area to the left of the nest. *Below*: View of the eggs after opening the top of the nest.



A hatching of the saltwater Crocodile (*Crocodylus porosus*) in the Andaman Islands.

Plate V



Places visited during
1975 and 1976 Survey

1. Diglipur
2. Shyamnagar
3. Manjudera
4. Radhanagar
5. Milengram
6. Swarajgram
7. Laxmipur
8. Parseemsagar
9. Shivpur-Kalipur
10. Nowgram
11. Parangara
12. Kalighat
13. Ramnagar
14. Stewart I.
15. Mayabandar
16. Panighat
17. Webe
18. Austen Strait
19. Betapur
20. Eratha
21. Rangat
22. Long I.
23. Kadamtulla
24. Aturgic Creek
25. Papitadera
26. Baratang
27. Bamboo Flat
28. Port Blair
29. Chidiatapu

ANDAMAN ISLANDS
From 1931 Census Report

Some offshore islands like North Reef, East I, Landfall I and islands in Ritchie's Archipelago have been reported in the past to have small or transient crocodile populations. Logging activities, cutting of cane, grass and palms and the growing need for fresh water and land will continue to pressure crocodiles in the Andamans. The Jarawa Reserve, Little Andaman and some parts of the Nicobar are reported to have good, reasonably intact populations; the latter two areas remain to be surveyed.

ANDAMAN CROCODILE CENSUS

Approximate figures based on initial field surveys and interviews. Does not include Jarawa Reserve.

Place	No. of Breeding Females	Total Crocodiles
North Andaman	50	100-200
Middle Andaman	20	50-100
South Andaman	10	20-30

RECOMMENDATIONS

(a) Complete survey to determine population and habitat available for crocodiles.

(b) Optimum areas should be offered complete protection as Crocodile Preserves, simultaneously the Wildlife Act should be enforced through adequate field staff.

(c) Consideration and drawing up of a crocodile conservation/management plan for the Islands.

ACKNOWLEDGEMENTS

We wish to extend our thanks to the Commissioner, Chief Wildlife Warden, Chief Conservator of Forests and many other members of the Andamans and Nicobar Forest Department for their kind help. Mr. Jerry Vaughan and family, Captain D. A. Beale, and Mr. and Mrs. Fred Burn provided warm hospitality enabling us to carry out the surveys. Others who provided valuable information and help are: Mr. George Allee, Mr. Mathews, DFO, Mr. Mukhopadhya, FRO, Captain Imtiaz, Captain Anand and numerous settlers interviewed at many tea shops and farms around the Islands.

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REVISION OF THE GENUS *DIPCADI* MEDIK. (LILIACEAE) IN INDIA AND ADJOINING REGIONS[1]

D. B. Deb and Syamali Dasgupta[2]

(*With ten text-figures*)

The paper presents a taxonomic revision of the genus *Dipcadi* Medik. (Liliaceae) in India and adjoining regions. 9 species and two varieties are described with all synonyms and their original citations. References of Indian regional Floras are included. A key to the species and varieties is given. Distribution and phenology of the taxa are traced distinctly. Exsiccata studied are cited. *Dipcadi hydsuricum* (Edgew.) Baker and *D. unicolor* (Stocks) Baker are relegated to synonymy of *D. serotinum* (L.) Medik. and *D. erythraeum* Webb & Berth. respectively. *D. madrasicum* Fischer & Barnes is reduced to a variety of *D. montanum* (Dalz.) Baker and a new combination is proposed thereon. Two new species and one new variety are described.

The genus *Dipcadi* was postulated by Medikus in Act. Acad. Theod. Palat. 6:431. 1790, on the basis of *Hyacinthus serotinus* L. collected from Spain. Medikus (1790) distinguished this genus from *Hyacinthus* L. on the basis of tubular, erect perianth lobes and numerous flat seeds. Ker-Gawler (1816) described the genus *Uropetalum* (Sphalm. *Uropetalon*) in Bot. Reg. t. 156. 1816 on the basis of sixfid, tubular perianth, lobes subduplicate to the tube, and numerous flat seeds. Edgeworth (1846), Dalzell (1850) and Stocks (1852) subsequently added some species to this genus from Indian subcontinent.

Reichenbach (1828), Endlicher (1836), Lindley (1836) and Kunth (1843) did not recognize the genus *Dipcadi*. Baker (1871) however, revived *Dipcadi* Medik. and relegated *Uropetalum* Ker-Gawl. to synonymy of the former. In his monographic studies Baker (l.c.) subdivided bulbous Liliaceae with racemose inflorescence into two groups, gamophyllous Hyacintheae and polyphyllous Scilleae and placed *Dipcadi* Medik. in the former group. Bentham (1883) did not lay any importance on such distinction and merged the Hyacintheae in Scilleae, thereby placing *Dipcadi* Medik. therein. Subsequent workers followed Bentham (l.c.) in keeping all the genera under a single group without subdividing the tribe. Engler & Prantl (1930), raised it to the rank of a subfamily in the name of Scilloideae. They, however, did not recognize any tribal status in it. Hutchinson (1960) on the other hand, did not recognise the subfamily.

About 55 species, distributed in Mediterranean region, Africa, Madagascar and India occur (Willis 1973).

The present paper is based on the study of specimens deposited in the Indian and few foreign herbaria. The species found in India in the broad sense are treated here.

Measurements of pollens are taken after acetolysis.

[1] Accepted December 1976.

[2] Botanical Survey of India, Calcutta.

Herbaria consulted

Symbols for the herbaria consulted are indicated in the parenthesis after the respective names as follows:

Central National Herbarium, B.S.I., Calcutta (CAL)
Western Circle, B.S.I., Poona (BSI)
Central Circle, B.S.I., Allahabad (BSA)
Southern Circle, B.S.I., Coimbatore (MH)
Northern Circle, B.S.I., Dehra Dun (BSD)
Blatter herbarium, Bombay (BLAT)
Forest Research Institute, Dehra Dun (DD)
Royal Botanic Garden, Kew (K)
Royal Botanic Garden, Edinburgh (E)
British Museum (Natural History), London (BM)
Linnean Society of London (LINN)

Dipcadi Medik. in Act. Acad. Theod. Palat. 6:431. 1790; Baker in Journ. Linn. Soc. 11: 395. 1871; Benth. & Hook. f. Gen. Pl. 3:809. 1883; Hook. f. Fl. Brit. Ind. 6:345. 1892; Cooke, Fl. Pres. Bomb. 2:769. 1907; Bamber, Pl. Punjab 441. 1916. *Hyacinthus* L. Sp. Pl. 317. 1753 & Gen. Pl. ed. 5:149-1754. *Zuccagnia* Thunb. Nov. Gen. Pl. 9. 127.1798 & in Roem. Arch. Bot. 2:2. 1799. *Scilla* Sims. Bot. Mag. 21. t. 859.1805. *Uropetalum* Ker-Gawl. Bot. Reg. 2:t.156, 1816. *Polemannia* Berg. ex Schlecht. in Linneae 1:260. 1826. *Tricharis* Salisb. Gen. Pl. 24. 1866.

Taxonomic characters

The following attributes were examined in a search of characters useful for taxonomic and diagnostic purposes in the genus.

Habit—Plants are erect or ascending 10-75 cm tall. Height of the plant varies within the species. All the species are bulbous and scapigerous. Leaves and scape arise simultaneously. *Bulbs* are globose, ovoid or ellipsoid; tunicated, outer scales scarious, inner fleshy; size varying from 10 to 45 mm in length and 10-40 mm across. *Leaves* are radical, with sheathing base, linear, subulate or falcate, parallel veined, glabrous, acute or acuminate at the apex. Breadth of the leaf has a characteristic range for each species but these ranges tend to overlap. The breadth of the leaf varies from 2 to 5 mm in *D. serotinum, D. erythraeum, D. montanum, D. minor,* from 5 to 7 mm in *D. maharashtrensis, D. saxorum,* and from 4 to 15 mm in *D. ursulae* and *D. reidii*. *Scape* is narrow, as long as leaves or longer, stiff, naked and terete. *Inflorescence* is a raceme, loosely few flowered or densely many flowered. Frequency of flowers in a raceme varies from species to species. In *D. ursulae,* the raceme is 6-14 flowered in var. *ursulae* and 22-35 flowered in var. *longiracemosae*. *Flowers* are small and bracteate; bracts are lanceolate or deltoid and acuminate or clawed. Bracts are generally scarious, but coriaceous in *D. maharashtrensis*. Length of the bract is characteristic of the species but the range overlaps. It is 3-5 mm long in *D. concanense,* 5-10 mm in *D. saxorum* and *D. montanum* var. *madrasicum,* 7-9 mm in *D. erythraeum,* 8-12 mm in *D. serotinum* and 10-26 mm in *D. ursulae*. Length of pedicel does not appear to be of any taxonomic significance. It elongates with maturity and varies considerably within a species. It is 2-8 mm in *D. montanum* and 6-10 mm in *D. saxorum* and *D. reidii*. Pedicel is stout in *D. saxorum, D. ursulae* and *D. reidii* where as in other species it is linear. Comparative length of bract and pedicel is of taxonomic significance in some species. The pedicel is longer than bract in *D. concanense,* whereas the bract is longer than the pedicel in *D. erythraeum, D. maharashtrensis* and *D. ursulae*. This together with other characters are useful in determination of species. Perianth segments are 6 in number in 2 whorls of three each, the outer perianth campanulate; lobes lanceolate, hooded, acute, tubercled at the subapex; inner perianth tubular, lobes deltoid, hooded, tubercled at the subapex. Flower length is more or less same in all the species except *D. concanense* which

is much longer, 25-36 mm. Outer and inner perianth lobes are subequal in *D. reidii*, both are 2/3 free above, whereas in *D. minor* both are 1/2 free above. *Stamens* 6, uniseriate, at the throat of the perianth tube, included; filament adherent to the perianth tube, free portion short in some group of species whereas longer in others. Anther is dorsifixed, versatile, introrse and dehiscing longitudinally. *Pollen* oblong, foveolate. *Carpels* 3, syncarpous; ovary superior, sessile or stipitate, oblong or obovoid, trilocular, septal nectaries present in the ovary; style long, linear; stigma trifid. Ovary is commonly obovoid, but oblong in *D. montanum* var. *madrasicum* and *D. reidii*. Stipe of the ovary varies in a species, even in the same plant. In the collection of *D. serotinum* by Aitchson from Tons valley, W. Himalaya, stipe of the ovary varies from 0 to 3 mm. Length of the style is more or less same except in *D. concanense* where it is exceptionally long, 23 mm. *Capsule* subglobose to obovoid, trilocular, trilobed, loculicidally dehiscent, pericarp crustaceous, thin. Characteristics of the capsule is diagnostic in some species like *D. montanum* and *D. erythraeum*. *Seed* 3-9 in each chamber, superposed, brownish black, glossy, varies from orbicular to rotund even in the same locule, flat, wrinkled, obscurely winged.

Very little work has been done on Cytology of this genus. Mahabale & Chennaveeraiah (1954, 1960) have worked on the karyotypes. Chromosome numbers of *D. serotinum, D. montanum, D. saxorum* and *D. ursulae* are reported as 2n = 8 or 64-68, 2n = 20, 2n = 10 and 2n = 20 respectively.

Indian species of this genus centre round Deccan peninsula from Maharashtra to Tamil Nadu and extend through Rajasthan to Kashmir, Himachal Pradesh and Uttar Pradesh in the North and Pakistan in the West and through Madhya Pradesh to Orissa in the east. 9 species in India.

Type: *Dipcadi serotinum* (L.) Medik.

KEY TO THE SPECIES

1. Flower small (8-15 mm long); style short (3-6 mm long)
2. Perianth segments of the outer whorl are united to 1/3 and those of the inner one upto 2/3 of the length
3. Pedicel filiform; filament adherent wholely to the perianth protruding only at the tip
4. Fruit as long as broad
5. Scape long (20-70 cm), 10-16 flowered; capsule stipitate .... *serotinum*
5'. Scape shorter (15-20 cm), 4-12 flowered; capsule sessile .... *erythraeum*
4'. Fruit broader than long .... *montanum*
6. Ovary narrowly obovoid, stipitate .... var. *montanum*
6'. Ovary oblong, substipitate .. var. *madrasicum*
3'. Pedicel stout; filament protruding 2-5 mm above
7. Bract as long as pedicel .... *saxorum*
7'. Bract much longer than pedicel
8. Bract coriaceous, acute ...... *maharashtrensis*
8'. Bract scarious, long acuminate ...... *ursulae*
9. Matured raceme short, 6-14 flowered .... var. *ursulae*
9'. Matured raceme long, 22-25 flowered .... var. *longiracemosae*
2'. Perianth segments of both the whorls are subequal, united upto 1/3-1/2 of the length
10. Bracts smaller (4-5 mm); filaments shorter (1-2 mm) .... *minor*
10'. Bracts larger (6-10 mm); filaments longer (4-5 mm) .... *reidii*
1'. Flower long (25-36 mm long); style longer (23 mm long) .... *concanense*

Dipcadi serotinum (L.) Medik. in Act. Acad. Theod. Palat. 6:431. 1790; Baker in Journ. Linn. Soc.. 11:397. 1871; Hook. f. Fl. Brit. Ind. 6:347. 1892; Bamber, Pl. Punjab 441. 1916. (Fig. 1).

Hyacinthus serotinus L. Sp. Pl. 317. 1753 (Type: Spain, Savage Microfische No. 438.4). *Scilla serotinus* Sims. Bot. Mag. 21.t.859. 1805

(Type: England, hort. *Woodfords* s.n.—not seen; plate cited above agrees with the description). *Uropetalon serotinum* Ker-Gawl. in Bot. Reg. 2:156. 1816. *Uropetalum hydsuricum* Edgew. in Trans. Linn. Soc. 20:88. 1846 (Type: Ludhiana, 1844, *Edgeworth* 105 K). *Dipcadi hydsuricum* (Edgew.) Baker in Journ. Linn. Soc. 11:397. 1871; Hook. f. Fl. Brit. Ind. 6:347. 1892; Collett, Fl. Simlens. 526. 1902; Bamber, Pl. Punj. 441.1916.

Bulbs 20-35 × 15-30 mm, globose or ovate. *Leaves* few, 18-34 × .2-.5 cm, linear, glabrous, acuminate at the apex, attenuated to the base. *Scape* 20-70 × .3-.4 cm, rigid, glabrous. *Inflorescence* 10-12 cm long, erect, 10-16 flowered, compact in young stage, loose on maturity. *Flowers* small, 8-14 mm long, white or pale pink coloured; bracts 8-12 × 4-5 mm, as long as the pedicel or longer, sometimes slightly smaller, lanceolate or deltoid-lanceolate, acuminate, scarious; pedicel 5-10 mm long. *Perianth* persistent, segments subequal, outer ones united upto 1/3 from the base, campanulate, lobes slightly longer, lanceolate, acute, inner 3 united upto 2/3 from the base, tubular, spreading at the tip, obtuse; perianth segments hooded, tubercled at the sub-apex, 5 nerved along the mid zone. *Stamens* at the throat of the perianth tube; anthers 2-4 × .75 mm, linear-oblong, dorsifixed, introrse; pollen grain oblong, 100-130 μ × 60-80 μ, foveolate; filament adherent to the perianth tube, slightly free above. *Ovary* 3-5 × 2-3.5 mm, sessile or stipitate, oblong or obovate, trilocular; stipe when present may be more than 1 mm; style 3-4.5 mm long, linear; stigma trifid. *Fruit* capsule, stipitate, 8-10 × 8-10 mm, as long as broad, loculicidally dehiscent, subglobose to obovate; pericarp thin, brittle, with parallel markings. *Seeds* 6-8 in each locule, sometimes more, 4.5-5 × 3.5-4 mm, brownish black shining, rotund, compressed, wrinkled, hard, narrowly winged.

Flowering time: February-June.

Fruiting time: March-September.

Ecology: Grows on the floor of the forest.

Distribution: Western Himalaya from Nepal to Kashmir upto an altitude of 2700 m, down to Saharanpur District of U.P.

Herbarium specimens examined:

INDIA: Kashmir: Mt. Tilla, 2700 m, 31-iii-1893, *Aitchison* 3 (CAL, DD, E). Himachal Pradesh: Tons valley, 900-1200 m, 13-v-1894, *Duthie* 14504 (CAL, DD); ibid. 5-v-1895. *Duthie* 15580 (CAL, DD); Simla, 2000 m, 19-vii-1910, *Rich.* 872 (K).

Uttar Pradesh: Dehra Dun, 21-v-1894, *Gamble* s.n. (flowered in Indian Botanic Garden, Calcutta, in April 1896) (CAL); ibid. (flowered in Indian Botanic Garden on 22-iii-1898) (CAL); Advicem Sodhi, 2200 m, 13-iv-1904, *Kabir* 14796 (K). Madhya Pradesh: Raipur, 21-ii-1907, *Haines* 2393 (K).

NEPAL: Karnali valley, 1200 m, 24-iv-1952, *Pollin, Sykes & Williams* 3964 (BM); Between Jungla and Gorgi, 2400 m, 8-viii-1952, *Pollin, Sykes & Williams* 5029 (BM); Simkot-Durpa, 3000 m, 17-vii-1968, *S. B. Malla* 14268 (BM); Suligad, 2700 m, 1-viii-1973, *S. Einarssa., L. Karby & B. Wetterhall* 2937 (BM).

PAKISTAN: Kagan valley, 2300 m, 31-v-1896, *Inayat* 20221 (CAL, DD); Jhadyor, 1700 m, May 1891, *Gamble* 22798 (CAL).

Note: *R. Wight* s.n. (E) collected from Peninsular India, differs in fruit. Capsules larger, straw coloured, 15-18 mm; seeds 5-6 × 4-4.5 mm, 14 seeds in each locule. Another gathering *R. Wight* s.n. (E) collected from Peninsular India has unusually small bracts and pedicels.

D. erythraeum Webb & Berth. Phyto. Canar. 3:341. 1848; Baker in Journ. Linn. Soc. 11:400. 1871; Cooke, Fl. Pres. Bomb.

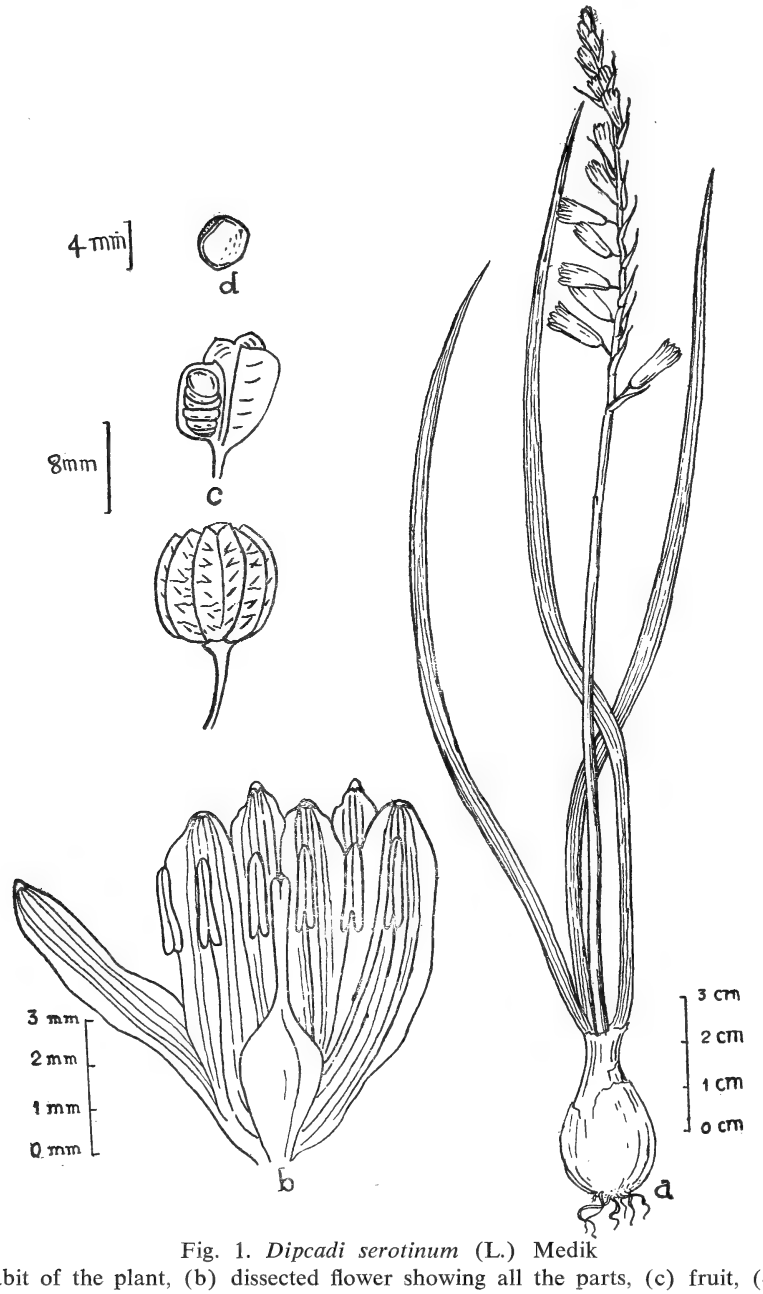

Fig. 1. *Dipcadi serotinum* (L.) Medik
(a) habit of the plant, (b) dissected flower showing all the parts, (c) fruit, (d) seed.

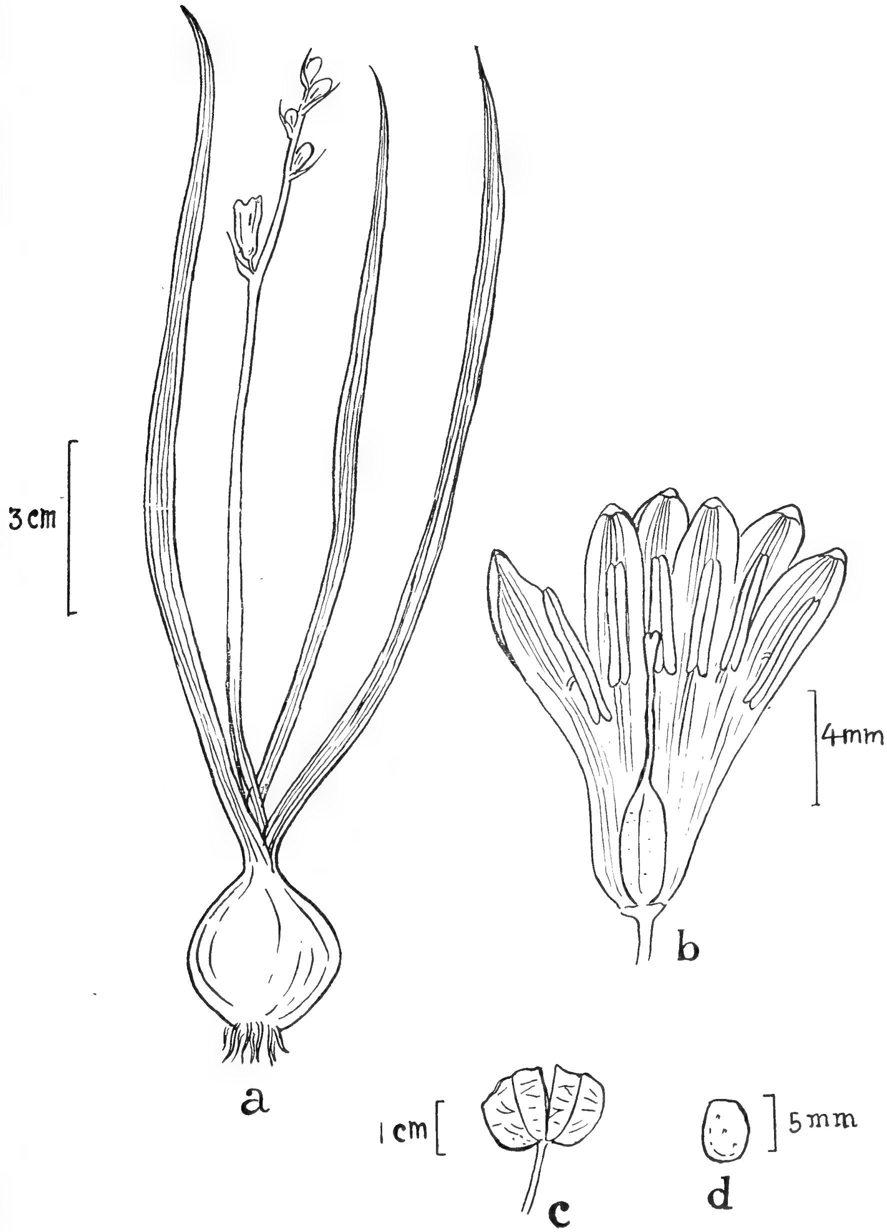

Fig. 2. *Dipcadi erythraeum* Webb & Berth.
(a) habit of the plant, (b) dissected flower, (c) fruit, (d) seed.

2:770. 1907; Blat. & Hallb. in Journ. Bomb. Nat. Hist. Soc. 26(4):972. 1920. *Uropetalum unicolor* Stocks in Journ. Bot. 4:180. 1852 (Type: Sind, lower hills, *J. C. Stocks* 634 lecto. K.; iso. CAL!). *U. erythraeum* Boiss Fl. Or. 5:286. 1882. *D. unicolor* (Stocks) Baker in Journ. Linn. Soc. 11:397. 1871; Hook. f. Fl. Brit. Ind. 6:346. 1892. (Fig. 2).

Bulbs 20-30 × 15-25 mm, ovoid. *Leaves* 5-6 close at the base of the scape, 15-20 × .2-.6 cm, broader below, sheathing at the base, glabrous, acute at the apex, falcate. *Scape* as long as leaves, 15-20 × .2-.3 cm, terete, stiff, erect, naked. *Inflorescence* loose, 4-12 flowered. *Flowers* 12-14 mm long, small; pedicel small, 2-3 mm long; bracts longer than pedicels, 7-9 mm long, deltoid, membranous to scarious, acuminate. *Perianth* segments subequal, outer ones slightly longer than the inner, united upto 1/3 from the base; inner united upto 2/3 from the base, lobes lanceolate, 5 nerved, hooded, spreading at the tip. *Stamens* arising from the throat of the perianth segments, included; filaments adherent to the perianth tube, slightly free above; anthers large, 4-5 × .7-1 mm, linear, sagitate, dorsifixed, versatile, introrse. *Ovary* sessile, ± 4 × 2 mm, oblong; style narrow, ± 4 mm long. *Fruit* sessile, 12-14 mm as long as broad, quadrate, retuse above and below. *Seeds* rotund, 6-7 mm across, compressed, brownish black, shining, narrowly winged.

Flowering time: August-September.

Ecology: It grows on the hills of the arid region after rain.

Local names: "Junglee Bussur" in Sind and Baluchistan.

Use: Bulbs are eaten in Sind and Baluchistan.

Distribution: Rajasthan to Sind and Baluchistan.

Herbarium specimens examined:

INDIA: Rajasthan: Bairaswara, 28-8-1969, *Wadhawa* 5028 (BSA).

PAKISTAN: Karachi, September 1895, (CAL); Sind, *Stocks* 634 (CAL).

D. montanum (Dalz.) Baker in Journ. Linn. Soc. 11:398. 1871; Hook. f. Fl. Brit. Ind. 6: 346. 1892; Cooke, Fl. Pres. Bomb. 2:769. 1907; Bamber, Pl. Punj. 441. 1916; Mooney, Suppl. Bot. Bih. Or. 201.1950. *Uropetalum montanum* Dalz. in Journ. Bot. 2:142.1850 (Type: Bombay, Sahyadri Mt., *Dalzell* s.n. K); Dalzell & Gibson, Fl. Bomb. 250.1861. var. *montanum*. (Fig. 3).

Bulbs 12-20 × 10-15 mm, ovoid. *Leaves* 3-8, shorter than the scape, 15-20 × .2 cm, linear, attenuated at the base, glabrous, acuminate at the apex. *Scape* 18-25 cm × 2-3 mm, erect, stiff. *Inflorescence* 5-15 cm long, loose raceme, 7-15 flowered. *Flowers* 11-13 mm long, small; pedicels 2-8 mm long; bracts 5-10 × 3-4 mm, as long as pedicels or longer, lanceolate or ovate, acuminate, clawed, scarious. *Perianth* segments outer longer, united upto 1/3 from the base, campanulate, lobes lanceolate, acute, inner ones united upto 2/3 from the base, tubular, tips spreading, obtuse, all hooded, tubercled at the subapex, mildly perfumed; nerves 5-6, colour white, or salmonpink or light brownish white, sometimes greenish inside. *Stamens* inserted at the throat of the tube; filament adherent along the perianth throughout the tube protruding at the tip; anthers 2-3 × .75 mm, linear-oblong, versatile, introrse; pollen oblong, 95-105 μ × 60-65 μ foveolate. *Ovary* stipitate, 3-5 × 1.5-2 mm, narrowly obovate-oblong, septal nectaries are present, stipe 1-2.5 mm; style 4-6 mm long, linear; stigma trifid. *Fruit* loculicidally dehiscent, much broader than long, narrowed at the base 5-10 × 10-15 mm, obovoid, deeply trilobed; pericarp thin, brittle, light brownish yellow, tranversely striated. *Seeds* 3-5 in each locule,

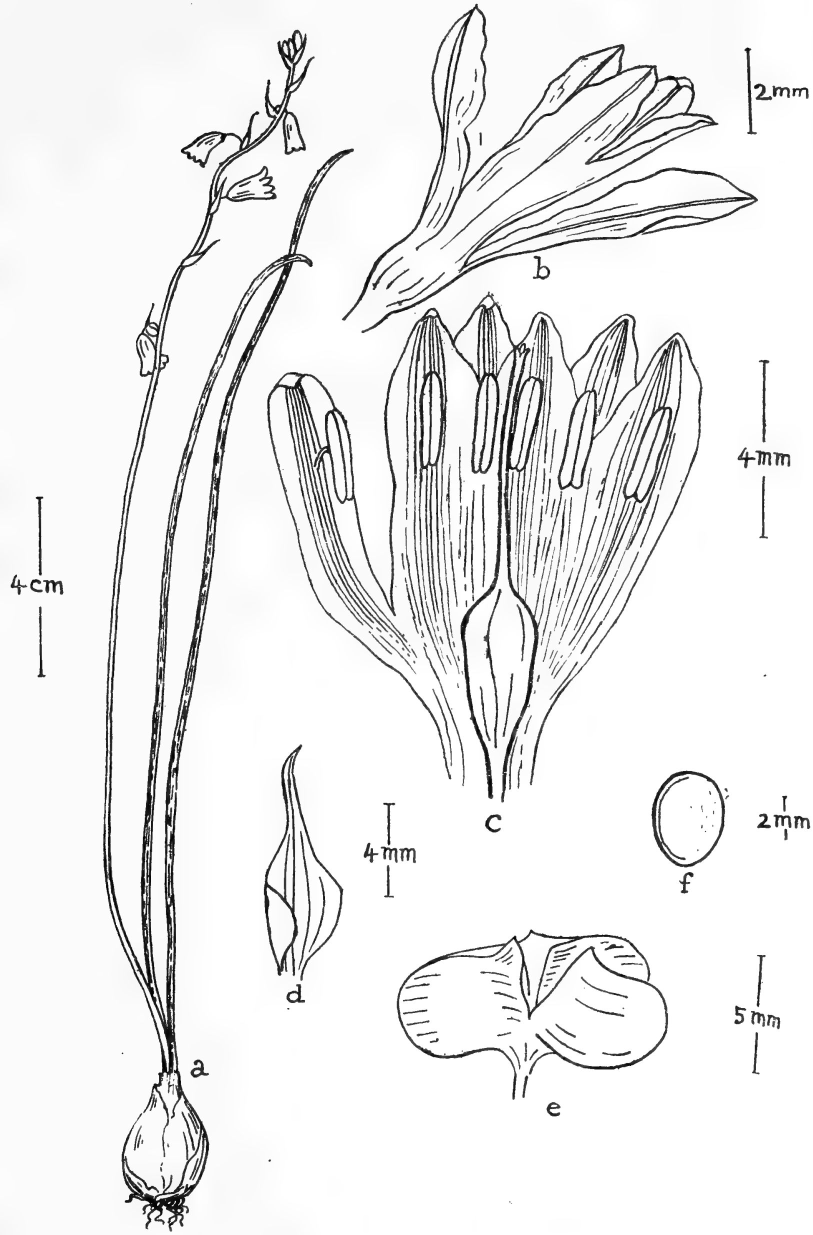

Fig. 3. *Dipcadi montanum* (Dalz.) Baker
(a) habit of the plant, (b) flower, (c) dissected flower showing all the parts,
(d) bract, (e) fruit, (f) seed.

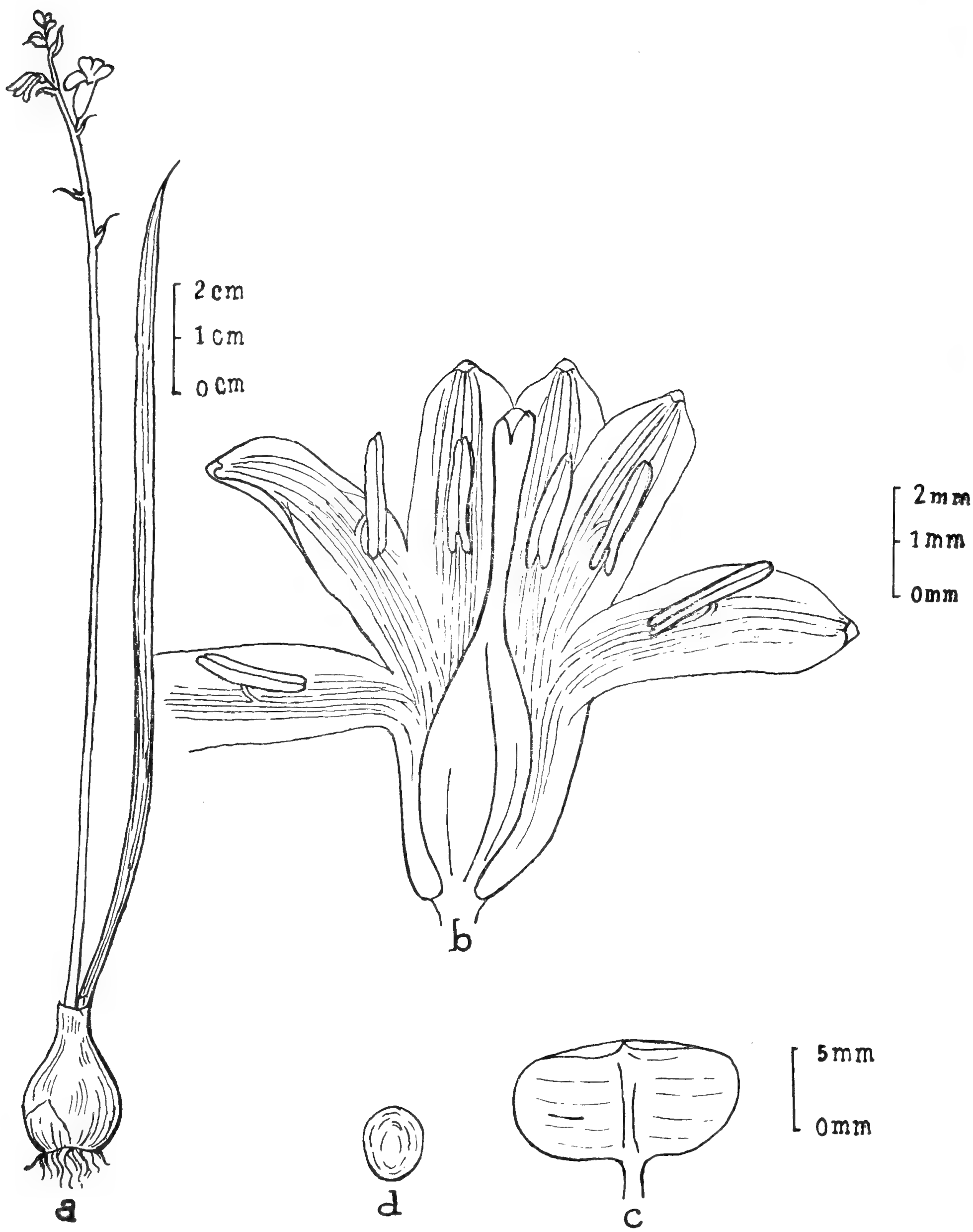

Fig. 4. *Dipcadi montanum* (Dalz.) Baker var. *madrasicum* (Barnes & Fischer) Deb et Dasgupta comb. et stat. nov.
(a) habit of the plant, (b) dissected flower, (c) fruit, (d) seed.

3.5-5 × 2-3 mm, orbicular, angular or ellipsoid, compressed, wrinkled, narrowly winged, brownish black, glossy.

Flowering time: July-August.

Fruiting time: July-August.

Ecology: Common on the open grass land; gregarious, on shallow soil and laterite plateau at an altitude of 1130-2000 m.

Cytology: Chromosome number is reported as 2n = 20 by Mahabale & Chennaveeraiah (1954, 1961).

Distribution: From Western coast of Deccan upto Orissa in the east 1160 m to 1300 m and rarely in W. Himalayas at an altitude of 2000 m.

Herbarium specimens examined:

Maharashtra: Malabar Concan, *Stocks* s.n. (CAL, E); *Law* s.n. (CAL, E); *Gibson* s.n. (CAL); Junar, 6-vii-1894, *Talbot* (CAL); Belgaum, 12-vii-1893, *Talbot* 2277 (BSI); ibid., 10-viii-1891, *Talbot* 3763 (BSI); Belgaum, 27-vii-1953, *Chennaveeraiah* 15755 (BLAT); ibid. July, *Ritchie* 1454 (E).

Madhya Pradesh: Bailadila, Bastar, 16-vii-1939, *Mooney* 1048 (K, CAL).

Orissa: Khandual Mali, 1100 m, south Kalahandi, 12-vii-1949, *Mooney* 3470 (K, DD).

Himachal Pradesh: Simla, Kaleemitia/Almora, 2000 m, 1859, *Maddens* 700 (E).

D. montanum (Dalz.) Baker var. **madrasicum** (Barnes & Fischer) Deb et Dasgupta comb. et stat. nov. Basionym: *D. madrasicum* Barnes et Fischer in Kew Bull. 1940: 301. 1941. (Type: Chingleput Dist., Tambaram, 70 m, Nov. 1937, *E. Barnes* 1801 lecto. K; ibid. Jan. 1939, *E. Barnes* 2085 para.K). (Fig. 4).

Bulbs 10-30 × 10-30 mm, ellipsoid or ovate. *Leaves* 2-3 on each bulb, 10-20 cm × 2-5 mm, linear, glabrous, acute. *Scape* 25-75 cm × 2mm, slender, glossy, erect, glabrous. *Inflorescence* 5-12 cm long, loose raceme, 5-12 flowered. *Flowers* 12-13 mm; pedicel very small, 2-4 mm, filiform; bracts as long as the pedicel or longer, 5-6 mm, deltoid, scarious, acuminate. *Perianth* segments outer ones united upto 1/3 from the base, campanulate, lobes obovate lanceolate, acute; inner ones united upto 2/3 from the base, tubular, tips spreading; all are slightly hooded, tubercled at subapex, 6 nerved. *Stamens* inserted; filaments arising from the base of the perianth, and adherent throughout the tube, slightly free above; anthers 2.5-3 × .75 mm, linear-oblong, dorsifixed, versatile, introrse. *Ovary* sessile or subsessile, 3.5-5 × 2.5 mm, ellipsoid or obovate-ellipsoid; stipe upto .5 mm long; style 3.5-4 mm, long, linear, stouter than that in var. *montanum;* stigma trifid. *Fruit* loculicidally dehiscent, about 7 × 12 mm, obovoid, narrowed at the base, deeply trilobed, straw coloured; pericarp thin. Seeds 4-5 in each locule, ovate-ellipsoid, 4-6 × 4 mm, obscurely winged, irregularly discoid, compressed, shining, brownish black.

Flowering time: May-September.

Fruiting time: July-November.

Ecology: Common in dry stream beds, sandy and marshy places, in scrub jungles and in crevices of rocks.

Local name: 'Katuvengaium' in Tamil. This name appears to be applied to other bulbous plants also.

Use: The bulb is eaten in times of scarcity.

Distribution: Distributed in Deccan, Tamil Nadu and also in Balaghat Plateau.

Herbarium specimens examined:

Madhya Pradesh: Balaghat plateau, May 1912, *Haines* 3586 (K).

Tamil Nadu: Kodumady, Tinnevelly distt., 333 m, 9-vii-1959, *Sebastine* 8403 (MH); Coimbatore, 1700 m, 29-vii-1930, *Narayanswamy* 3961 (MH); Guduvancheri, Chingle-

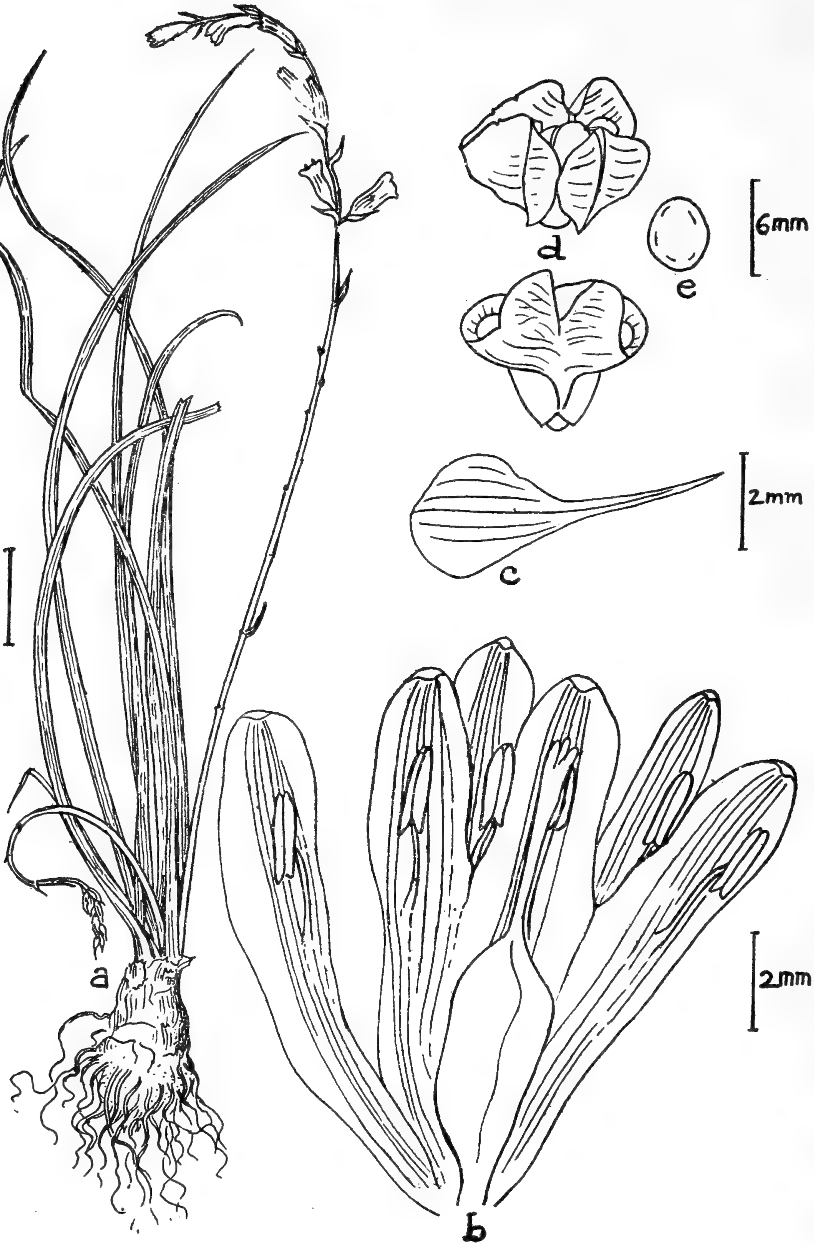

Fig. 5. *Dipcadi saxorum* Blatter
(a) habit of the plant, (b) dissected flower, (c) bract, (d) fruit, (e) seed.

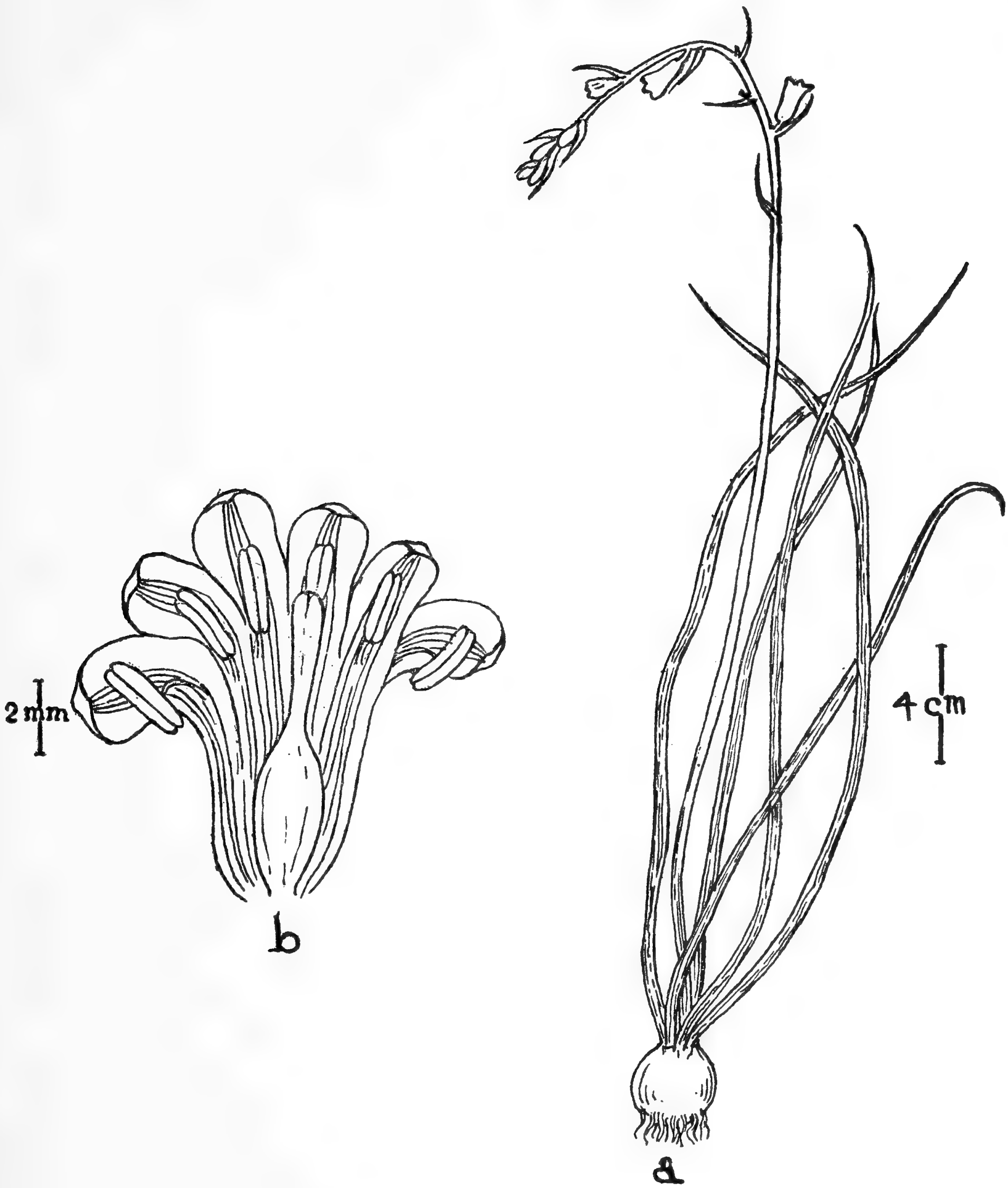

Fig. 6. *Dipcadi maharashtrensis* Deb et Dasgupta
(a) habit of the plant, (b) dissected flower.

put distt., September 1939, *Barnes* 2180 (K).

D. saxorum Blatter in Journ. Bomb. Nat. Hist. Soc. 32:736. 1928 (Type: Salsette, about 330 m, Aug. 1917, *Blatter & Hallberg* 1 BLAT—not seen). (Fig. 5).

Bulbs 15-20 × 15-20 mm, globose; adventitious roots, closely arising from the base. *Leaves* 16-25 cm × 5-7 mm, linear, acuminate, glabrous. *Scape* longer than leaves, 20-40 cm × 2-3 mm, glabrous. *Inflorescence* loose raceme, 15-20 flowered. *Flowers* about 10 mm long; pedicel stout, 6-10 mm long, bracts 5-7 ± 3 mm, ovate, acuminate, scarious, shorter than pedicel. *Perianth* segments outer united upto 1/3 from the base, campanulate, slightly longer than inner; inner united upto 2/3 from the base, tubular; all the perianth lobes hooded at tips, tubercled at the subapex, veins 5-6, parallel, convergent along midzone; white with green stripes along the middle of the perianth segments, sometimes buff coloured, turning to orange. *Stamens* at the throat of the perianth tube, included; filaments arising from the base of the perianth, adherent throughout, protruding above; free portion 3-4 mm long, filiform, broader at the base, acute at the apex; anthers 2 × .75 mm, oblong, dorsifixed, versatile, introrse; pollen oblong, 105-120 μ × 70-80 μ, foveolate. *Ovary* 3.5-4 × ± 2 mm, oblong-obovoid, trigonous, conspicuous septal nectaries present, stipitate, stalk ± 1 mm; style ± 4 mm long, stout; stigma slightly thicker than style, trifid. *Fruit* 8-10 × 10-13 mm, loculicidally dehiscent, pericarp thin, brittle, crustaceous, light brownish yellow in colour. *Seeds* many, 4-9 in each chamber, superposed, 4-5 × 3 mm, orbicular, ellipsoid or quadrangular, compressed, wrinkled, hard, wingless, brownish black, dull.

Flowering time: June-October.

Fruiting time: July-November.

Ecology: Very common on rocky hills.

Cytology: Chromosomes are reported as 2n = 12 by Mahabale & Chennaveeraiah (1954), Chennaveeraiah & Mahabale (1962).

Distribution: Western Deccan, abundant in Borivli.

Herbarium specimens examined:

Mahrashtra: Borivli, Salsette, 8-viii-43, *Blatter* 2353-2361 (BLAT): ibid., 25-vii-1953, *Santapau* 15714A-D (BLAT); ibid., 26-vii-1959, *Santapau* 23159 (BLAT); ibid., 25-x-1956; *Rukmini Bai* 79 (BLAT); ibid., 27-vi-55, *Rukmini Bai* 303, (BLAT): ibid., 26-vii-59, *Merchant* 1194, (BLAT); ibid., 24-viii-1957, *Merchant* 173 (BLAT); bulbs brought from Kanheri caves, Salsette and planted in St. Xavier's College Garden, 25-ix-56, *Rukmini Bai* B.R. 473 (BLAT); Borivli, 11-viii-52, *Fernandez* R. 87 (BLAT); ibid., 25-vii-53, 1351 (BLAT); ibid., 9-viii-53, 1398 (BLAT).

Dipcadi maharashtrensis Deb et Dasgupta in Journ. Bomb. nat. Hist. Soc. 72(3):822. 1975. (Type: Panchgani, 5-ix-1955, *Rukmini Bai* BR 933 (BLAT). (Fig. 6).

Herbs bulbous, scapigerous. *Bulbs* globose, small, about 2.5 cm × 2.5 cm, tunicate, rooting profusely from the base. *Leaves* radical, about 6, shorter than the scape, 25-30 cm × .5-.7 cm, linear, broadest at the middle, plicate, entire, acute, coriaceous glabrous; veins, 8-14 in number. *Scape* about 36 cm long, about .4 cm across at the base, narrowing upwards to .1 cm across at the apex, slender, terete, glabrous, naked. *Inflorescence* raceme, about 13 cm long, loose, bearing about 12 flowers. *Flower* 11-13 mm long; pedicels stout, 2-3 mm long; bracts persistent, much longer than the pedicels, 10-20 × 3-3.5 mm, entire, subulate, coriaceous. *Perianth* outer ones longer, united upto 1/3 from the base, campanulate; inner ones united upto 2/3 from the base, tubular; lobes 2-2.5 mm broad; obovate-lance-

olate, obtuse, tubercled at the sub-apex, nerves 5, convergent towards the apex. *Stamens* included, filaments adherent to the inner perianth tube, remaining free for about 1-2 mm above, filiform; anthers 2 celled, oblong, 2.5-2.7 × .6-.7 mm, dorsifixed, introrse, dehiscing longitudinally. *Ovary* stipitate, broadly oblong, 3.5-4 × 2.5-3 mm, with numerous ovules in axile placentation; style stout, 4-5 mm long about .7 mm across.

Distribution: Localised in Maharashtra State.

Herbarium specimens examined:

Maharashtra: Panchgani, 5-ix-1955, *B. Rukmini Bai* BR 933, cultivated in St. Xavier's College, Bombay, where it flowered in September (BLAT).

D. ursulae Blatter in Journ. Bomb. Nat. Hist. Soc. 32:735. 1928 (Type: Maharashtra State, Panchgani, 1500 m August, 1925, *Blatter* P 74 BLAT!) var. *ursulae*. (Fig. 7).

Bulb 10-20 mm across, globose or ovoid, small with many fibrous roots from the base. *Leaves* 4-6, longer than the scape, 15-30 cm long, 4-7 mm broad, linear, coriaceous, plicate, sheathing at the base, grass green. *Scape* 1 or 2 per bulb, 15-20 cm × 2-6 mm, terete, glabrous, naked. *Inflorescence* raceme, 6-14 flowered, close in bud, ultimately becoming loose, and elongating to 12 cm long. *Flowers* 9-12 mm long, 18 mm across, small; pedicel 5-7 mm long, stout; bracts much longer than the pedicel, 10-26 mm long, ovate, long acuminate, scarious, 2-4 mm beyond the bud. *Perianth* segments, mildly fragrant, white to pale cream or orange red, sometimes green outside or lower surface of the perianth pink brown or greenish along the midnerve and whitish margin, outer lobes 6-7 mm long, recurved at the middle and bent downwards, tube smaller, 3-4 mm long, inner perianth lobes shorter than the outer, connate to about the middle, tubes 5 mm long, lobes 3-4 mm as long as broad, recurved at right angle to the tube, apex hooded, subapex tubercled, veins 5, closely parallel along the middle, convergent at the tip; filaments adherent to the perianth tube, included; free part 2-3 mm long, broader at the base, tapering at the apex; anthers at the mouth of the tube, 2 × .5-.75 mm, oblong or linear-oblong, dorsifixed, introrse, dehiscing longitudinally; pollen oblong, 85-105 μ × 60-80 μ, foveolate. *Ovary* stipitate, 4-5 × 1.5-2.5 mm, narrowly obovoid-oblong, trigonous, stipe nearly 1 mm long, conspicuous septal nectaries are present, style 5-6 mm long, stout or filiform linear, slightly thickened at both ends, papillose, especially in the upper half; stigma trifid, thicker than the style or not. *Capsule* loculicidally dehiscent, as long as broad, young capsule longer than broad; bracts persistent to fruits. *Seeds* ± 6 × 5 mm, semiorbicular, compressed, glossy, black.

Flowering time: June-August.

Fruiting time: June-August.

Ecology: Abundant on gravelly, grassy hill top.

Cytology: Chromosome number is reported as 2n = 20 by Mahabale & Chennaveeraiah (1954) and Chennaveeraiah & Mahabale (1962).

Distribution: Found only in Maharashtra State.

Herbarium sheets examined:

Maharashtra State: Trombay hills, 26-vii-1958, *Merchant* 606 & 607 (BLAT); ibid., 1-viii-1959, *Merchant* 1197, 1198 (BLAT); ibid., 26-vii-58, *Shah* 9692 (BLAT); ibid., 10-viii-1957, *Merchant* 90 (BLAT); ibid., 26-vii-58, *Balamani B.* 88 (BLAT); ibid., 26-vii-58, *Shah* 9894 (BLAT); Panchgani tableland, 1-viii-1953, *Chennaveeraiah* 15756 (BLAT); top of Shivneri hills (south west), 25-vii-63, *Ansari* 88729 (BSI); Mangni hill near Khamgaon, 6

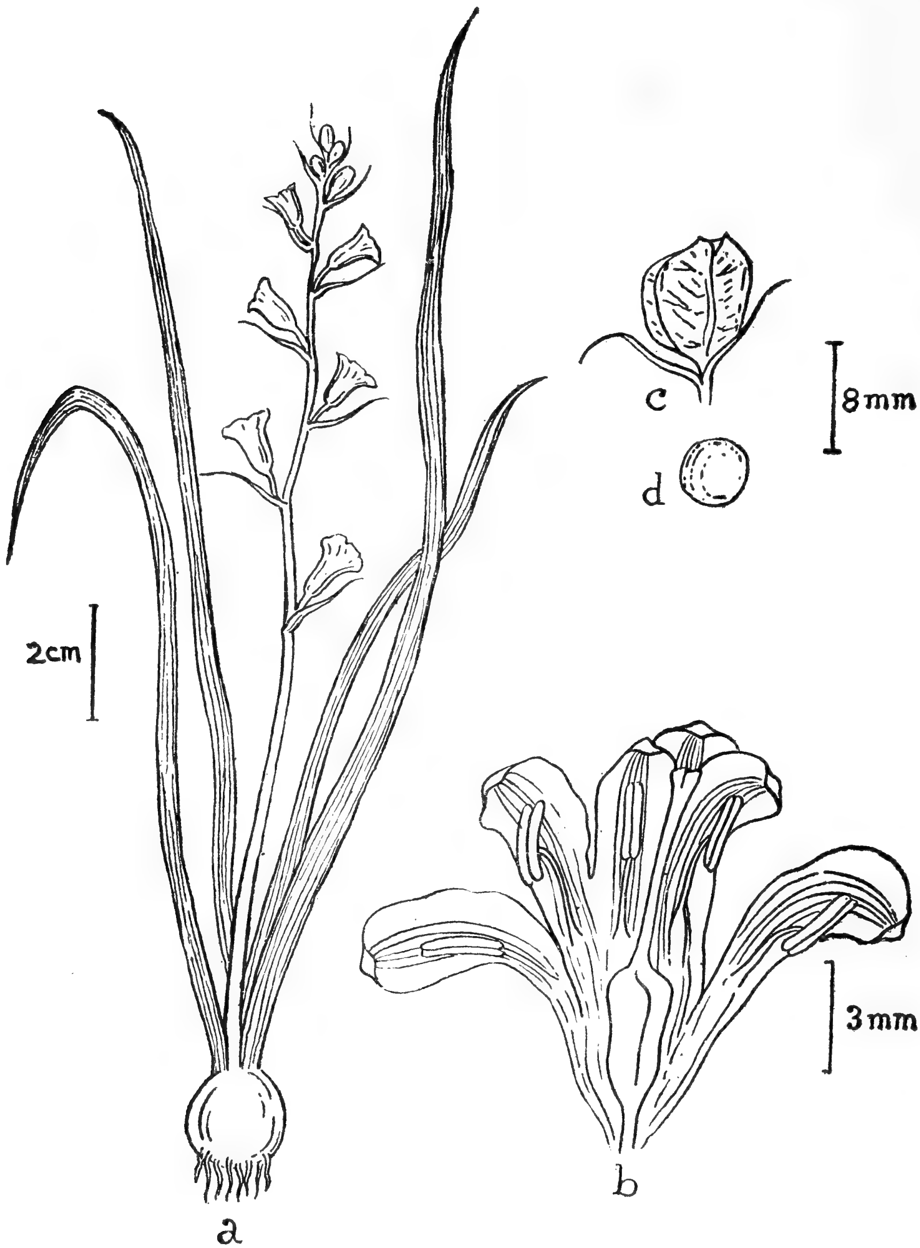

Fig. 7. *Dipcadi ursulae* Blatter
(a) habit of the plant, (b) dissected flower, (c) fruit, (d) seed.

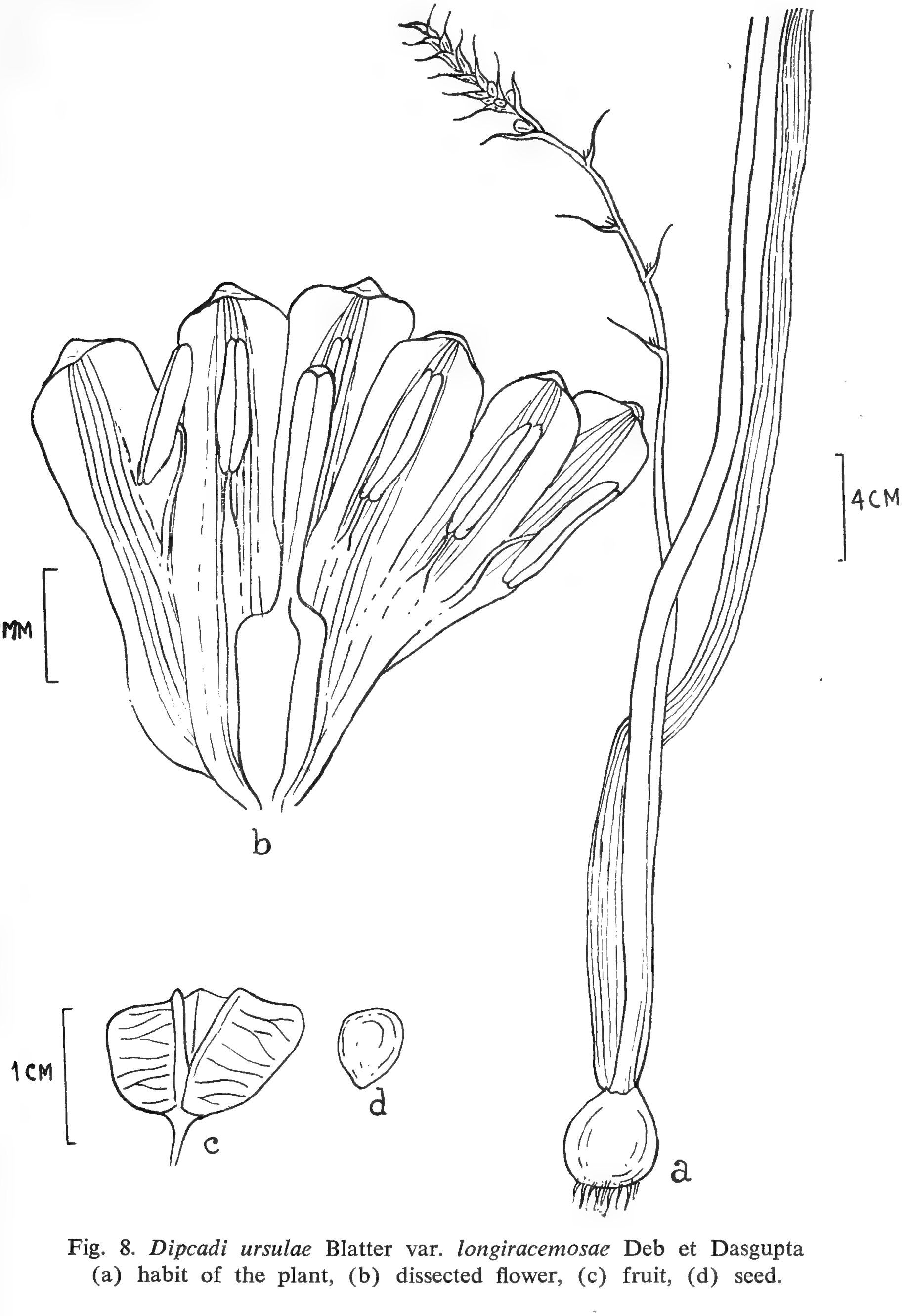

Fig. 8. *Dipcadi ursulae* Blatter var. *longiracemosae* Deb et Dasgupta (a) habit of the plant, (b) dissected flower, (c) fruit, (d) seed.

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miles N.W. of Junnar, 29-vi-64, *Hemadri* 99527 (BSI); Shivneri hills, (flowered and fruited in BSI garden), 25-vi-65, *Hemadri* 107099 (BSI).

D. ursulae Blatt. var. **longiracemosae** Deb et Dasgupta in Journ. Bomb. Nat. Hist. Soc. 72(3):823. 1975 (Type: Girner hill, Junagadh 25-viii-58, *P. V. Bole* 743 BLAT—Holotype and ibid. 29-viii-52, *P. V. Bole* 851 BLAT—Paratype). (Fig. 8).

Herbs 2/3-1 m tall, scapigerous, bulbous; bulbs ovoid, small, 3-4.5 × 3-4 cm, white, rooting from the base. *Leaves* 1-6, radical, 30-66 × .5-1.5 cm, linear, glabrous, entire, acute, veins 12-20. *Scape* one or two, arising from the bulb, 30-75 cm long, .4-1.2 cm across, terete, smooth, naked, light brownish yellow in colour. *Inflorescence* raceme, 10-30 cm long, dense in early stage, loose when matured, 22-35 flowered. *Flower* white; bracts persistent, 10-13 × 3-4 mm, deltoid, long acuminate, scarious, plicate, entire, much longer than the pedicel; pedicels 5-7 mm long. *Perianth* 9-11 mm long, corolline, outer ones longer, united upto 1/3 from the base, campanulate, lobes obovate-lanceolate, recurved at the middle, obtuse, tubercled at the subapex; inner ones shorter, united upto 2/3 from the base, tubular, lobes obovate-lanceolate, obtuse, recurved at the tip, all are hooded, nerves 5-7, prominent, convergent towards the apex. *Stamens* included; filaments adnate to the inner perianth tube, protruding 2-3 mm above, free portion filiform, anthers 2 celled, linear oblong, 3-3.5 mm × about .7 mm, dorsifixed, introrse, dehiscing longitudinally. *Ovary* sessile, narrowly obovate-oblong, trisulcate, 4.5-4.7 mm × about 1 mm, with numerous ovules in exile placentas; style 4.5-4.7 mm long, stout, broadening above; stigma trifid. *Fruit* 7-10 × 9-10 mm, loculicidally dehiscent, light yellowish brown in colour, as long as broad. *Seeds* 3.5-4 × 3.5 mm, semi-rotund, obovate or ellipsoid, compressed, glossy, brownish black in colour, narrowly winged, wrinkled, many in each loculus.

Flowering time: July-August.

Fruiting time: July-August.

Ecology: On wet rocky slopes of hills.

Distribution: Maharashtra and Gujarat States.

Herbarium specimens examined:

Maharashtra: Girnar hill, Junagadh, 25-viii-1958, P. V. Bole 743 (BLAT); ibid., 29-viii-52, *P. V. Bole* 851 (BLAT); Maharashtra; Shivneri (North East), 27-vii-1963, *Ansari* 88785 (BSI).

D. minor Hook. f. Fl. Brit. Ind. 6:346. 1892 (Type: Concon, Hewraplain, Aug. 1859, *Dalzell* s.n. K a fragment only; no bulb, leaf and fruit, only 5 scapes, two of which bear flowers others without any; flowers small). Cooke, Fl. Pres. Bomb. 2:770. 1907.

Bulbs 18-20 × 15-20 mm, ovoid, with fibrous roots at the base. *Leaves* 12-15 cm × 2-3 mm, linear, plicate, glabrous. *Inflorescence* loose raceme, 6-12 flowered. *Flowers* 8-9 mm; bracts 4-5 × 3-4 mm, deltoid, acuminate, scarious; pedicel 3-5 mm, small, filiform. *Perianth segments,* outer narrower than the inner, all are united 1/3-1/2 from the base, 7-9 veined. *Stamens* at the throat of the perianth tube; anther 2.5-3 × .7 mm oblong, dorsifixed, introrse; filament adherent to the tube, free portion 1-2 mm, filiform. *Ovary* 3-3.5 × 1.5-2 mm narrowly obovoid, sessile; style 3-5 × .5 mm long, linear; stigma trifid.

Distribution: In Deccan, rare.

Herbarium sheets examined:

Peninsular India Orientalis, *R. Wight* s.n. (E).

Note: This is allied to *Dipcadi erythraeum* Webb & Berth. and *D. serotinum* (L.) Medik., differing from the former in having shorter

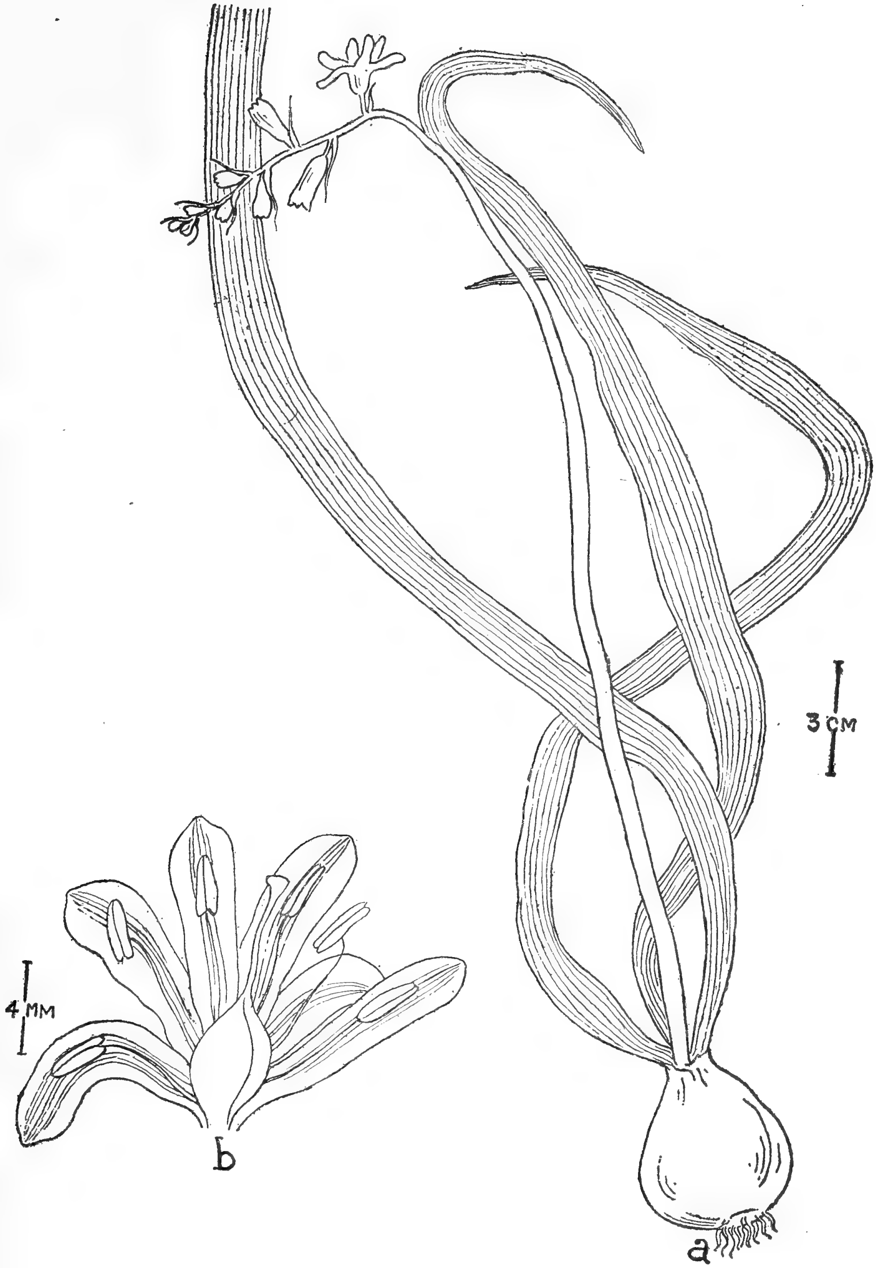

Fig. 9. *Dipcadi reidii* Deb et Dasgupta sp. nov.
(a) habit of the plant, (b) dissected flower.

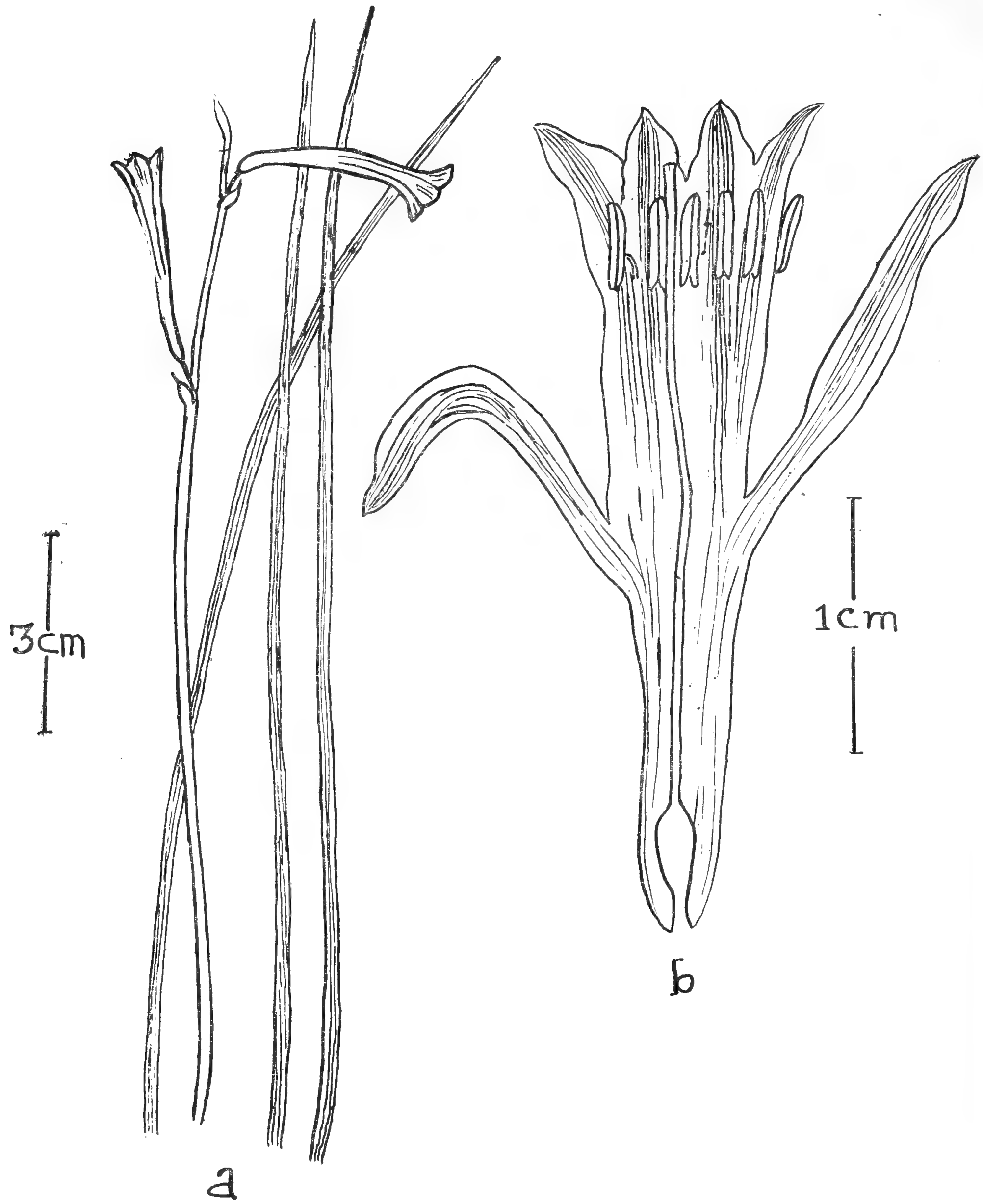

Fig. 10. *Dipcadi concanense* (Dalz.) Baker
(a) habit of the plant, (b) dissected flower.

bracts and many flowered (6-12) inflorescence, and from the latter in shorter size of the plant, perianth segments 7-9 nerved and united 1/3-1/2 from the base.

D. reidii Deb et Dasgupta sp. nov. Species haecab *D. serotino* differt foliis latioribus, bracteis latioribus *P. erianthiis* interioribus *c.* 1/3 longitudine adhaerentibus filamentorum segmentis liberatis multum longioribus. (Type: Malphagarh, Byauswells, about Kali valley, 2300 m, 16-vii-1886, *J. R. Reid* s.n. A—holotype, B—isotype E!). (Fig. 9).

Herbs bulbous, scapigerous, with waxy lusture; bulbs ovoid, about 4 × 3.5 cm shining white in colour; disk rounded, rooting below. *Leaves* 3-4 in number, as long as scape or longer, 30-40 × 1-1.2 cm, broadly linear, broadest above the middle, acute, entire glabrous, thin in texture, light brown in colour when dry; veins adpressed on the lower surface. *Scape* 30-40 cm × .3-.4 cm, terete, glabrous. *Inflorescence* raceme 4-20 cm long, bearing 10-18 flowers, compact at the early stage, loose on maturity. *Flower* campanulate, 13-15 mm long, light brown in colour when dry; pedicel 6-10 mm long, linear; bracts persistent, as long as pedicels, 6-10 × 5-6 mm, ovate, lanceolate, scarious. *Perianth* united upto 1/3 from the base forming tube, remaining free above; lobes narrowly oblong, thickened along the veins frilled; veins 5-7, subparallel. *Stamens* included; filaments adnate to the perianth tube, protruding 4-5 mm above, filiform, broader at the base, attenuated to the apex; anthers narrowly oblong, about 2.5 × .7 mm, 2 celled, introrse, dorsifixed. *Ovary* sessile, about 5 × 3 mm, trisulcate, oblong, glabrous, with many ovules in axile placentas; style 5.5-6 mm long, linear; stigma obscurely trifid.

Distribution: W. Himalayas.

Herbarium sheets examined:

Malphagarh, Byuswells, Kali valley 2300 m, 16-vii-1886, *Reid* s.n. (E).

D. concanense (Dalz.) Baker in Journ. Linn. Soc. 11:399. 1871; Hook. f. Fl. Brit. India 6:346. 1892; Cooke, Fl. Pres. Bomb. 2:769. 1907. *Uropetalum concanense* Dalz. in Journ. Bot. 2:143. 1850 (Type: Bombay, Dalzell. s.n. K!); Dalzell & Gibson, Bomb. Fl. 250. 1861. (Fig. 10).

Herbs scapigerous, bulbous. *Leaves* 3-4 on the bulb, 5-22 cm × ± 2 mm, linear, acute, broader at the base, *Scape* 18-28 cm long, narrow, erect, terete, glabrous. *Inflorescence* loose raceme, 2-6 flowered. *Flowers* long, 25-36 mm, salvar-shaped; tube narrow, 8-12 mm long and 2-4 mm across; pedicel 5-10 mm long, filiform; bracts 3-5 mm long, deltoid, scarious, acuminate, as long as the pedicel or shorter. *Perianth* segments 6 nerved, shining white in colour, outer lobes ± 15 × 3 mm, lanceolate, acute, fimbriate, spreading, inner ones 3-4 × 3 mm. *Stamens* at the throat of the tube; filament adherent to the tube, free portion 2 mm long, filiform; anthers narrowly oblong, 3 × .75 mm dorsifixed, introrse. *Ovary* stipitate, ± 2.5 × 1.5 mm, obovoid oblong; stipe ± 1.5 mm; style ± 23 mm long, narrow, papillose; stigma, trifid. *Capsule* stipitate; lobes rounded. *Seeds* 6 in each locules, compressed, shining black, rotund.

Distribution: Malabar-Konkan coast.

Herbarium specimens examined:

Malabar-Concan, *J. C. Stocks* s.n. (K, E, CAL); *Law* s.n. (K, E, CAL).

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THE ELEPHANT IN U. P. (INDIA)—A RESURVEY OF ITS STATUS AFTER 10 YEARS[1]

V. B. SINGH[2]

(*With two maps and a plate*)

The first systematic census of elephants in Uttar Pradesh was carried out during the years 1966 and 1967. The data so collected was satistically analysed and the results were published as a paper in Vol. 66 of this *Journal*. A decade has elapsed since the last census and there have been drastic changes both in the extent and quality of the elephant habitat. It was accordingly considered necessary to carry out a fresh census so that the problem could be viewed in the light of their population trend in relation to the new factors which have adversely affected the normal living conditions of these animals.

CENSUS

The same method which was followed for the census during 1966 and 1967 was adopted. The details of this method are:

(i) The census was carried out simultaneously over the entire range comprising the forest divisions of West & East Dehradun, Siwalik, Lansdowne, Bijnor, Kalagarh, Corbett National Park, Ramnagar, Tarai Bhabhar and Haldwani under the supervision of the Wild Life Wardens in their respective regions and under the over all direction of the Chief Wild Life Warden, U.P.

[1] Accepted July 1977.

[2] Chief Wildlife Warden, U.P.

(ii) Each region was divided into convenient units and a party of wild life and forest guards was assigned to each unit under the supervision of an officer of the rank of an Assistant Wild Life Warden or Forester.

(iii) Three copies of a map of each unit were prepared on a suitable scale for marking the location of herds on the map during each count and for studying the movement of herds on subsequent counts. For the sake of accuracy three counts were made and between two counts sufficient gap was provided to allow reasonable movements of the herds.

(iv) A particular unit allotted to one party for the first count was given to another party for the second count and to a third party for the third count. In order to ensure independent assessment, the enumeration figures of one party were not given or divulged to another party.

(v) The whole operation was planned well in advance and before the actual days of count every effort was made to trace and locate the elephants in each unit with the help of available territorial staff and local labour and other persons.

(vi) On actual days of count, the party on locating the elephants, wrote down the number of herd and total number of elephants in that herd on the map at the place of its location as accurately as possible. Thus 3/8 meant that the third herd encountered by the party had eight elephants in it.

Results—Over a period of nearly one year between March 1975 and May 1976, six counts were carried out on the following dates:

(1975 *Census*)

First count	7-iii-75
Second count	7-iv-75
Third count	7-v-75

(1976 *Census*)

First count	23-iii-76
Second count	23-iv-76
Third count	23-v-76

The abstracts of the results are given below region (Wildlife) wise for all the 6 counts under Tables 1 & 2. Detailed results for each Forest Division is given only in respect of the third count of 1976 census on Table 3 for reasons of space.

TABLE 1

CENSUS OF ELEPHANTS IN 1975

Counting date	Dehra·dun region	Kotdwara region	C·N.P.	Western region	Total
1	2	3	4	5	6
1st Count					
7-iii-75					
Male	8	48	9	14	79
Female	9	85	3	16	113
Calves	3	35	2	7	47
Lone tuskers	—	—	—	6	6
Total:	20	168	14	43	245
2nd Count					
7-iv-75					
Male	9	61	9	22	101
Female	11	116	11	18	156
Calves	5	51	5	6	67
Total:	25	228	25	46	324
3rd Count					
7-v-75					
Male	12	71	10	22	115
Female	14	111	19	24	168
Calves	10	63	17	13	103
Total:	36	245	46	59	386

TABLE 2

CENSUS OF ELEPHANTS IN 1976

Counting Date	Dehradun region	Kotdwara region	C.N.P.	Western region	Total
1	2	3	4	5	6
1st Count					
23-iii-76					
Male	33	57	11	9	110
Female	76	99	27	19	221
Calves	23	36	14	13	86
Lone tuskers	—	—	—	8	8
Total:	132	192	52	49	425
2nd Count					
23-iv-76					
Male	18	58	22	18	116
Female	30	126	43	16	215
Calves	14	33	25	5	77
Lone tuskers	—	—	—	11	11
Total	62	217	90	50	419
3rd Count					
23-v-76					
Male	10	82	34	23	149
Female	18	113	59	29	219
Calves	5	51	35	20	111
Lone tuskers	—	—	—	11	11
Total:	33	246	128	83	490

TABLE 3

DIVISION-WISE CENSUS FIGURES OBTAINED IN THE THIRD COUNT DONE ON 23-v-1976

Wild life region	Name of Forest Division	Male	Female	Calves	Lone tuskers	Total
(i) Dehradun region	Siwalik	1	1	—	—	2
	West Dehradun	4	13	3	—	20
	East Dehradun	5	4	2	—	11
(ii) Kotdwara region	Lansdowne	64	90	38	—	192
	Kalagarh	**18**	23	13	—	54
	Bijnor	—	—	—	—	—
(iii) C.N.P.	C.N.P.	34	59	35	—	128
(iv) Western	Ramnagar	2	1	2	4	9
	Tarai Bhabar	—	—	—	—	—
	Haldwani	21	28	18	7	74
	Total:	149	219	111	11	490

Notes: C.N.P. is Corbett National Park.

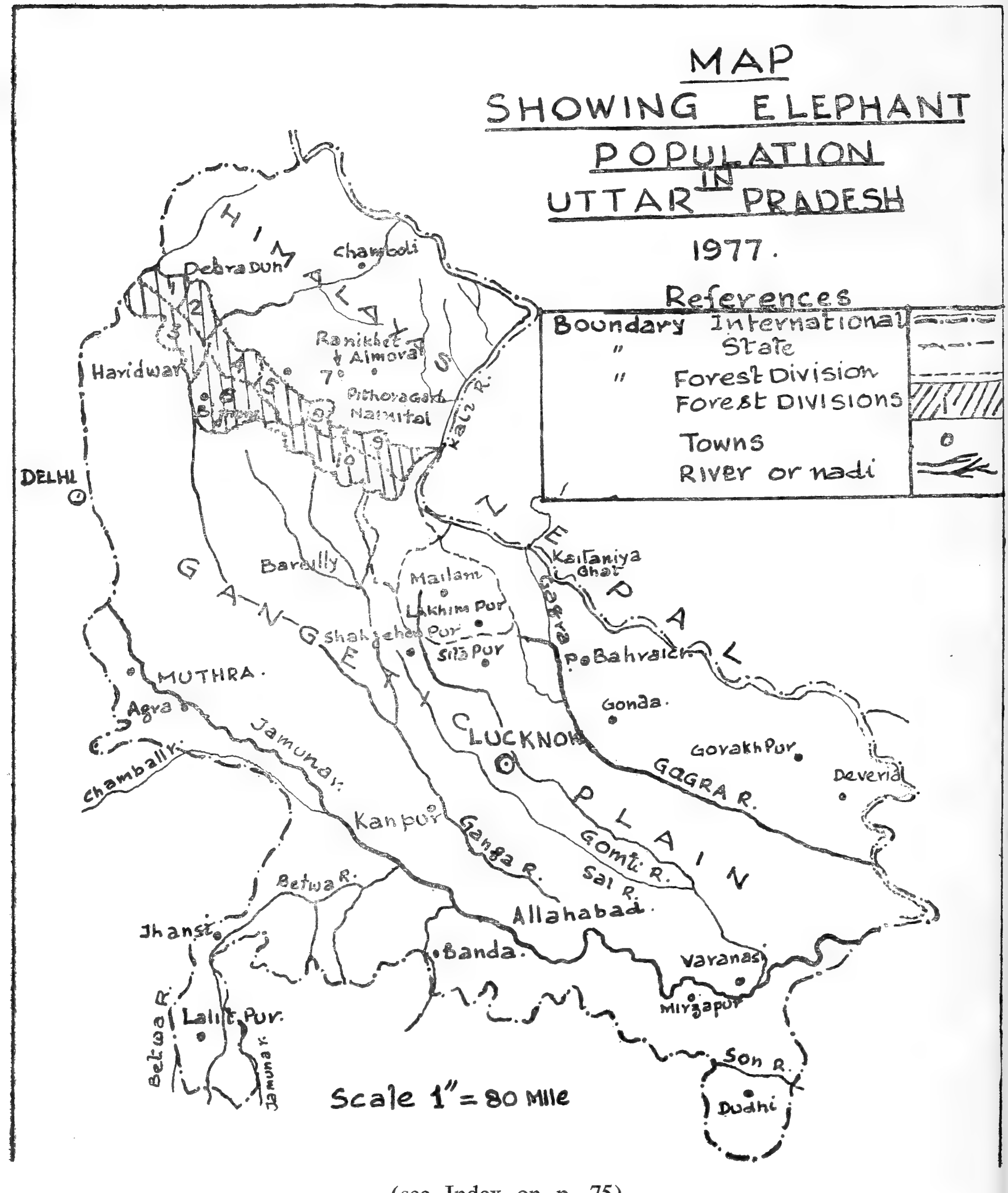
The census carried out during 1976 is the latest and has been done after the comparative stabilisation of the elephant population subsequent to the filling of Ramganga reservoir. The results of the 1976 census are summarised in Table 4.

TABLE 4

Category	I count 23 iii.76	II count 23.iv.76	III count 23-v-76	Total	Average	Percentage
Male	110	116	149	375	125	28
Female	221	215	219	655	218	49
Calves	86	77	111	274	91	20
Tuskers (Lone)	8	11	11	30	10	3
Total:	425	419	490	1,334	444	100

Calculated X^2 = 7.93, whereas tabulated X^2 at 95% confidence and 4 d.f. is 9.49. This proves the hypothesis that all the three counts represent the same population. We may, therefore infer that elephant population consists of 28% males, 49% females, 20% calves and 3% lone tuskers.

In order to estimate 95% confidence interval for numbers in each category the following calculations were done:



(see Index on p. 75)

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Wildlife region	Nos. of Divn.	Name of forest division	Total nos. of Elephant population
I. Dehradun region	1	Siwalik forest division	2
	2	West Dehradun forest divn.	20
	3	East Dehradun forest divn.	11
II. Kotdwara region	4	Lansdown forest division	192
	5	Kalagarh forest division	54
	6	Bijnor forest division	—
III. C. N. P.	7	Corbett National Park	128
IV. Western region	8	Ramnagar forest division	9
	9	Tarai Bhabar forest divn.	—
	10	Haldwani forest division	74
			490 Total
N. Kheri Dn.	11	Dudwa National Park	25

Category	pi	npi	qi	npi qi	$\sqrt{npiqi}$	$\sqrt{npiqi}$	95% confidence interval
Male	.28	125	.72	90	9.5	19	106 to 144
Females	.49	218	.51	111	10.5	21	197 to 239
Calves	.20	91	.80	73	8.5	17	74 to 108
Tuskers (Lone)	.03	10	.97	10	3.0	6	4 to 16

On the basis of the evidence furnished by the data as given above the population of elephants in U.P. has risen to just over 500.

Discussion

A comparison of the census results carried out in 1967 and 1976 shows that there has been an increase of nearly 130 heads during this period. (The maximum number of elephants as per 1967 census was 380 while that for the 1976 is 507). The maximum number of females during 1967 census was 180 which should produce at least 30 calves per year. Assuming that the survival percentage is not more than 60%, nearly 18 calves should have been added annually and over a period of 9 years the total increase in the population should have been by about 162. The increase in the population as indicated by the 1976 census is not too far off and considering the various adverse factors which have acted against their normal living and breeding conditions can be taken to be quite reasonable. The sex ratio remained stationary. The percentage of young ones stayed at 20% of the total population. Lansdowne Forest Division and Corbett National Park hold more than 2/3 of the total population in the State and the survival of elephants in U.P. depends on the preservation and development of their habitats in these two areas.

Important changes in the elephant habitat

During the course of the last 10 years, very drastic changes have taken place in the elephant habitat in this State which have brought

about distinct changes in the population in the affected regions. It will be worth while discussing in detail the following important factors:

(i) Reduction in the total area of the elephant habitat.
(ii) Construction of Chilla-Rishikesh power channel in Lansdowne Forest Division.
(iii) Filling up of the Ramganga reservoir in and near the Corbett National Park.
(iv) Clearance of forest in Nepal bordering Dudwa National Park in U.P.

(i) *Reduction in the total area of the elephant habitat*:

The census carried out during 1966-67 clearly indicated their range in U.P. and was estimated to cover nearly 2,55,000 acres of forest land spread over Dehradun East, Dehradun West, Siwalik, Lansdowne, Kalagarh and Haldwani Divisions and Corbett National Park. Since then not only their range in each of the above Divisions has increased as elephants have moved further into the interior and into areas never occupied before, but they have started spending considerably more time in some other Divisions like Bijnor, Ramnagar and Tarai and Bhabhar Divisions which are contiguous to their old habitat. The total forest area included in all these Divisions comes to 17,45,000 acres. While nearly, 2,50,000 acres out of this could still be considered most suitable for them, they had to extend their range out of pure necessity to about 1/3 of this area. During the last 10 years a total of nearly 1,65,000 acres have been brought under mechanised plantations after clearing the natural vegetation, which provided food and fodder to the elephants. The areas brought under plantations provided optimum cover, food and water to the elephants and it is difficult for them to keep to their normal habits about movement, local migrations etc., after the loss of these areas. Not only grass lands have disappeared but their main fodder which consisted of rohoni (*Mallotus philippensis*) growing in sal forests has been removed under intensive sal regeneration operations. The total effect of these factors has thus been:

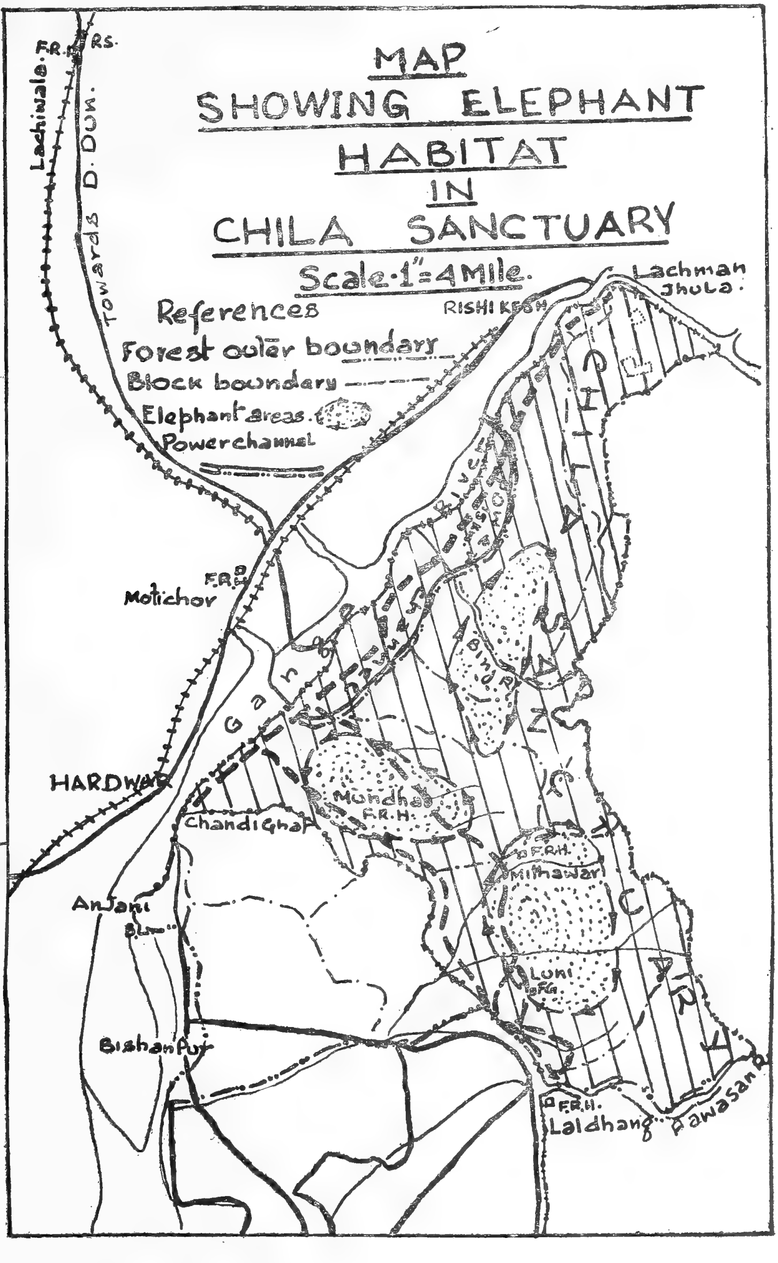
(i) reduction in the habitat.
(ii) reduction in food potential in the existing habitat.
(iii) movement into areas so far not used as their range. These areas are naturally not as rich in food potential and can provide them subsistence only for a short period.

(ii) *Construction of Chilla-Rishikesh Power Channel*:

As the census figures show, Kotdwar wild life region comprising Lansdowne, Bijnor and Kalagarh Forest Divisions have the maximum number of elephants which varies between 168 (March 75 count) to 246 (May 77 count). Lansdowne Division has always contained the highest number of elephants not only in that region but in the entire State. In this division also, there are only two ranges which hold the concentration of elephant population. These two ranges Gohri and Laldhang are endowed with all the requirements which go to make an area suitable for elephants. The area has a variety of topography consisting of hilly, undulating terrain and open grassland bounded on the Western and Eastern borders by two big and perennial sources of water namely the rivers Ganges and Rawasan. There are large number of streams and *nalas* scattered over the entire tract which provide water till the beginning of summer months. There is abundant fodder in the tract which not only has its major portion under miscellaneous forests, but the hill portion carries the richest bamboo forest in the State. The open grass-

Above: Young tusker. *Below*: Taking the elephant calf to camp after its capture.

land between the Ganges and the forests in Gohri range, consisting of Chilla and Kunao *Chaurs* extended over an area of nearly 15 sq. km and provided not only access to the Ganges but grazing during the summer when bamboo and other forests could not provide enough food. All these favourable conditions, therefore, made it only logical that out of 192 elephants in the Division (May 76 count), as many as 177 were living in these two ranges.



A Power channel, known as Rishikesh-Chilla Power channel is being dug along the fringe of the forest on the left bank of the river Ganges. This channel which is 10 metres deep takes off from the Ganges at Kunao and then runs almost parallel to the river for about 14 km before it rejoins the river near Chilla. The famous Kunao and Chilla *chaurs* (grasslands) which provided grazing during the lean months of summer now lie between the channel and the river Ganges and are not available to the elephants. During the period of channel construction the entire chaur area has been occupied by labour colonies and staff and a chain of stores for machines and material.

This channel has created the following problems to the elephants as also to other wild life:

(i) As the river Ganges has become inaccessible, the elephants of Gohri range have to face acute shortage of water. The only places from where the elephants can reach the river are the two ends of the channel near Kunao and Chilla. There will be artificial concentration of elephants at these two ends, resulting in severe damage of the forests.

(ii) Nearly 15 sq km of area, which includes at least 800 hec of grassland has also become inaccessible and lost to them because of the colonies etc. There has thus been considerable shrinkage of their habitat.

(iii) Seasonal migration of elephants of this area to the forests of Doon valley (E & W Dehradun Division and Siwalik Forest Division) has further been reduced and more or less stopped. This has further reduced their range.

(iv) Stoppage of intermixing of the herds from this area with those of Doon Valley herds is likely to have genetic ill-effects of inbreeding in the long run.

(v) Pressure of grazing has immensely increased in Gohri and Laldhang ranges. Damages to the forest crop by elephants has very considerably increased. An idea of the magnitude of damage can be had by the price obtained from the sale of trees uprooted and broken by elephants. During 1977, the sale fetched as much as Rs. 10,00,000/-. Some species of trees which were so far comparatively safe from elephant damage particularly Sal are being badly debarked upto the top and are drying *en masse*. Damage to bamboo clumps is also more noticeable as elephants have started climbing the hills even during the summer for fodder and water.

(vi) Elephants appear to have become more aggressive in behaviour. Although there is no established 'rogue' at present cases of elephants chasing labourers, graziers and passers-by are more frequent. Some elephants have started raiding agricultural crops of villages adjoining Kotdwara range particularly during the winter. In the last 2 or 3 years there have been persistent complaints from the villages on this score.

(vii) To meet their demand of water, elephant herds of Laldhang range have to visit some areas of Bijnor Forest Division lying between Kotawali and Ghariawali during the summer. They visit these areas during the night and go back to Laldhang range by morning. During their night stay, they do considerable damage to the plantations of Bijnor Forest Division.

Efforts are however being made to mitigate the suffering caused to elephants and other wild life in the area. Four tanks have been constructed on the left side of the power channel towards the forests in which water will be fed from the channel when it is commissioned. At one place the channel, when it crosses a stream has been taken over a bridge which

provides sufficient space and height for elephant herds to pass underneath. This can provide access to the Ganges provided the grassland between the channel and the Ganges remains unoccupied. But the threat to this area is very much there and will be discussed separately later on in this note.

(iii) *Filling up of the Ramganga reservoir*:

Corbett National Park together with the adjoining forests of Adnala, Palain and Sonanadi (Hathi kund) ranges of Kalagarh Forest Division served as complete range for elephants in that area and provided food for the entire year. There used to be local migrations from bamboo forests to grasslands during the summer months beginning from March. The entire pattern of migration, herd size and population underwent a drastic change on account of the filling up of the Ramganga reservoir during the 1974 rains. The reservoir extends over an area of nearly 90 sq km and cuts off the Corbett National Park from the rest of the elephant range by vast stretches of water.

To assess the effect of the reservoir on the elephant population in the Park, it will be worth while looking at the census figures for the Park for periods before and after the filling of the reservoir.

Date of census	No. of elephants in C.N.P.
15-iv-67	41
30-v-67	38
15-vi-67	27
7-iii-75	14
7-iv-75	25
7-v-75	46
23-iii-76	52
23-v-76	128

The above figures show that there was a considerable decrease in the elephant population in the Park in the beginning of 1975 and a marked increase subsequently. At present (May 1977), the elephant population in the Park stands at 128.

The forest blocks of Adnala, Palain and Hathikund are rich in bamboo. In the past most of the elephants migrated to these forest blocks during the rains and winter. Towards the beginning of March when bamboo leaves start drying the elephants started returning to the Park and stayed mostly in the Patil Doon valley near Boxar, Dhikala and Khinananli where there are extensive grasslands. Adjoining thick sal forests mixed with miscellaneous crop provided them shelter in the day. These combined with abundant water supply in the Ramganga river provided excellent habitat during the summer.

The pattern of movement in and out of the Park remained almost the same every year till 1974, when the reservoir was formed submerging the Ramganga valley upto Dhikala and Sonanadi valley upto Hathikund. The normal migratory routes namely (i) Sonanadi-Dudhia-Boxar, (ii) Halduparao-Tumeria-Dhikala; and (iii) Baillanallah-Gaujera-Phulai were blocked. Most of the elephants had moved out of the Park before their routes were cut off on account of submergence and they could not find their way back to the Park for sometime. The areas in Adnala, Palain and Hathikund blocks were not adequate to support a large elephant population for a longer period during the year. The elephants had therefore, to struggle to explore new routes of migration in which they were ultimately successful by April 1975. This route is a long track passing through Bailanal compartments 1, 3, 7, 8, 14, 15 and 20, Gaujera compartments 7, 8, & 10 and then to the Park through Kanda compartments 4, 3 & 2.

Since the year 1975 the pattern of migration has accordingly, changed considerably. In the rainy season also when hardly a few lone tuskers remained in the Park before 1975,

large herds have been noticed there from Dhikala to Dhangarhi & Paterpani. They go right up to Bijrani in the south-eastern corner of the Park where they were never observed before. During the summer months the elephants collect near Dhikala and Khinanuli. Heavy damage to *rohini* trees has been noticed in the forests near Dhikala and Khinanuli. Most of the *shisham* trees have their barks ripped off in the islands along the Ramganga banks. They have started debarking *Sal* also, though not on a scale being done in Gohri range in Lansdowne Division. The damage being done by these herds of elephants, who now stay in the Park in larger numbers over the entire year is very heavy. The forests are bound to suffer and some of the tiger habitats are bound to be ruined.

(iv) *Clearance of forests in Nepal bordering Dudwa National Park*:

It was only rarely that one or two lone elephants visited the forests of North Forest Division which borders with Nepal. The forests of Nepal existed right up to the border over long stretches. During the past few years, the Nepal Government has adopted the policy of clearing these border forests to settle people from the interior of the country. In the process vast chunks of forests have disappeared not only along the border but also from areas far inside the country. The elephants which used to live in these forests were turned into refugees and were left to find shelter for themselves. A herd of 23 elephants, consisting of 9 males and 11 females and 3 calves strayed into the forests of North Kheri Forest division on 23rd December 1975. An area of 495 sq km of this Division was declared by the State Government, to be converted into a National Park at the time these elephants moved into our territory. Accordingly no action was taken to drive the herd out of the area, even though they damaged the various installations of the Forest Department, trampled and fed on agricultural crops in the chain of farms along the southern and Southeastern border of the forest and created terror for the Railway workers who pestered the forest department to take action against the elephants for the proper running of trains in the area.

The notification about the creation of Dudwa National Park was issued on 21-1-1977. The herd has now become permanent resident of the Park and has not left it since it came into the area. The latest reports indicate that since their arrival two calves have been born and the strength has gone up to 25.

Dudwa National Park has never been an elephant range. The rich *Sal* forests of the Park do not provide adequate food to the elephants. Except for *rohini* there is not much to feed on as the grasslands in the area have now been converted into plantations. The crop of *rohini* has also diminished on account of their persistent removal in the interest of *Sal* regeneration. The paucity of food has forced the elephants to divide into small groups of 3 to 10 heads. Never have all the 23 elephants been observed together as one herd. The groups have to move long distances in search of food. They have been observed to travel 20 to 30 km, every night. Damage to farms and other interests has increased. The shortage of food will intensify damage to the forests as the herd has now come to stay in the Park permanently. We will have now to build up the food potential in the Park for this herd also. Stoppage of all forest exploitation in the Park which includes giving up the silvicultural practice of keeping down rohini for Sal regeneration and exclusion of other culture operations will certainly help in the augumentation of food supply. Recourse will be taken to create grasslands and to grow

fodder trees including bamboo to provide food throughout the year.

It is necessary to persuade the Government of Nepal to give up the policy of clearing such forests which form part of elephant range. A proper survey of elephant population and their important habitat has to be carried out in Nepal so that such areas as provide for elephant population are not disturbed and destroyed.

Sanctuaries in the elephant range

As indicated earlier, the total area of the elephant range is 17,45,000 acres, i.e. 6,980 Sq km. This excludes the Dudwa National Park, which has never been its normal habitat. The following sanctuaries and National Parks exist in this range:

(i)	Rajaji Sanctuary (Siwalik Division)	249.00 Sq km
(ii)	Motichur Sanctuary (East Dehradun Division)	90.00 Sq km
(iii)	Chilla Sanctuary (Lansdowne Division)	249.00 Sq km
(iv)	Corbett National Park	525.00 Sq km
	Total:	1,113.00 Sq km

The area under parks and sanctuaries thus forms about 16% of the total range area. Another sanctuary covering an area of 160 sq km to be known as Kaladhungi sanctuary is proposed to be created in Haldwani Forest Division and it is hoped that the required notification will be issued within two months. The total percentage of the range area under sanctuaries will thus rise to 18%. If we include Dudwa National Park also in the elephant range, the total range area will become 7580 sq km and the area under sanctuaries and Parks will be as much as 23% of the range area. While forest exploitation is totally stopped over 300 sq km of Corbett National Park and the entire 494 sq km of Dudwa National Park, normal forestry operations continue over the rest of the areas under sanctuaries.

The three main areas of elephant concentration namely Gohri & Laldhang ranges of Lansdowne Division, Corbett National Park and part of Haldwani Division will be covered by Chilla sanctuary, Corbett National Park and the proposed Kaladhungi sanctuary respectively, Forest management in Chilla & Kaladhungi sanctuaries has to be oriented to create suitable conditions for elephants.

Elephant trapping:

Wild elephants in U.P. have been under complete protection for almost a century under the Elephant Protection Act of 1879. During the last 10 years there has been an increase of nearly 130 in the elephant population but what is more important is the shrinkage in their habitat. The reduction in the suitable habitat combined with a variety of adverse factors enumerated above has brought the elephants in conflict with human interests. The pressure from various quarters to reduce their number could produce conditions similar to that created in 1964, when the Government of U.P. issued orders to shoot them over their entire range. As a result of this order a general massacre of elephants followed in which 28 elephants were shot and many more escaped wounded to die later on. With a view to avoid a repetition of 1964 massacre, it was decided to catch elephants upto the maximum of their annual recruitment.

The number of females in the elephant population is around 200. The interval at which a female elephant calves is nearly 5 years and it can safely be assumed that nearly 40 calves are born every year. Even if the survival

percentage is taken at 60% nearly 25 calves are added every year to the population. We can safely remove 20 to 25 elephants every year and stabilise the population in the State.

We accordingly decided to catch elephants upto a maximum of 25 in number by the method of 'Mela Shikar' which is practiced in Assam and is the most humane of all elephant catching methods known. We engaged expert 'phandis' from Assam and started departmental catching operations from January 1977 in Lansdowne Division. Till the end of June 1977 we caught 18 elephant calves about 5 to 6 years of age, which include 6 males and 12 females. Training operations were carried on simultaneously. The trapping operations have been suspended during the rains and will be resumed from next winter.

It is proposed to dispose of the captured elephants in the following three ways:

(i) Export of elephant calves in exchange for rare and valuable animals for our Lucknow and Kanpur Zoos.

(ii) Utilisation for departmental use.

(iii) By sale in the open market.

A serious threat:

There is a proposal to establish a paper mill near Chilla in the grass chaur between the Ganges and the power channel. This mill when established will be disastrous to the elephants and other wild life of Chilla sanctuary. During the construction period of the power channel there was great deal of human activity which resulted in damage to the forests. While adverse factors created by the power channel as enumerated earlier will persist for all time to come, it was hoped that after the construction work is over, the area will settle down and peace and quiet would return again to recoup the habitat. But if the proposed plan for the establishment of a Paper Mill materialises, there is no future for this newly created sanctuary and for the elephant population. The proposed location of the Paper Mill on the left bank of Ganges could easily be changed to the right bank. But this is not being done on the grounds that the Paper Mill should be located in a backward district Garhwal which is on the left bank of the river Ganges and not in Dehradun District which is on the right bank of the river. This trivial reason is going to ruin the sanctuary, pollute the environment and create conditions under which wild animals including elephants will either disappear or move far into the interior to create new problems for the villages and others. It is for the conservationists to voice their protests and move the Government to either abandon this project or to shift it to a different location.

Conclusion

In Uttar Pradesh the survival of elephants is neither threatened by poachers for their tusks, nor by trapping or their direct annihilation. Their survival however depends upon the manner in which their habitat is preserved and protected. Further mutilation of the ecological stability in their home range is bound to create conditions where the elephant population will either lay waste the vegetation by their concentration in a limited area or they will disintegrate by dividing themselves into small groups scattered over large areas. The factors which are working against the survival of elephants have been enumerated above. It is imperative that immediate attention is paid to eliminate these adverse factors and optimum conditions are created for their survival. Chilla sanctuary in Lansdowne Forest Division should be free from imbalances being created in the ecosystem by the construction of the power channel and the Paper Mill.

EFFECT OF MOON PHASE AND LUNAR CYCLE ON THE LIGHT TRAP CATCH OF TOBACCO CATERPILLAR *SPODOPTERA LITURA* (FABR.) (LEPIDOPTERA: NOCTUIDAE)[1]

S. M. VAISHAMPAYAN[2] AND S. K. SHRIVASTAVA[3]

(*With two text-figures*)

Effect of moon phase and lunar cycle on the light trap catch of Tobacco Caterpillar *Spodoptera litura* (Fabr.) was studied in detail during 1974-75 at Jabalpur. Light source was 250 Watt. Mercury Vapor lamp.

The fluctuations in the light trap catch observed over a period of 12 lunar cycles in a year showed a rthythmic pattern following a lunar rhythm. At same degree of moon phase the light trap catch was found to be higher in ascending phase (no moon to full moon).

Several workers in the past have reported relationship between the light trap collection and moon-phase or brightness of the moon (Dina Nath 1923; Williams 1936 and 1940; Nemec 1971; Agee *et al.* 1972 and Bowden & Church 1973). Most of the workers attempted to compare response of insects on full moon and no moon days only. They observed greatest response of insects during no moon period and lowest during full moon period. Bowden & Church (1973) examined the light trap catches of some insect species in relation to the regular changes in night illumination of the lunar cycle.

Apparent observations with the light trap catch of *Spodoptera litura* indicated existence of such a relationship. Attempts were made to study in detail the relationship between the response of moths towards light trap and day to day change in the moon phase and degree of illumination in a lunar cycle. The data of one year from June 1974 to May 1975, covering 12 lunar cycles were carefully analysed and results are discussed in this paper.

MATERIALS AND METHODS

One light trap unit was installed in an open field with light source *c* 3 metres above the ground level. Light trap unit was composed of 2 components—(A) trapping device made of 24 gauge G.I. sheet consisting of a funnel (60 cm top diameter) three baffles (45 × 23 cm in size) mounted vertically on a rim of the funnel placed equidistant and projecting towards the centre of the funnel and a rain shade over the baffles. (B) Insect collection cage 2 × 1 × 1 metre in size covered by a wire mesh screen. Light source was 250 Watt. Mercury Vapour lamp.

The position of moon phase for each calendar day of observation was determined from Indian Almanac published from Bombay. For practical purpose and data analysis the period

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of one lunar cycle of $29\frac{1}{2}$ days was corrected to 30 days cycle. The two halves of the lunar cycle, i.e. ascending cycle (from no moon to full moon) and descending cycle (from full moon to no moon) were standardised to 15 days each. Little adjustments had to be made for these corrections.

The intensity of moon light was measured in terms of degree of moon phase. Full moon is considered as 360° phase and no moon as

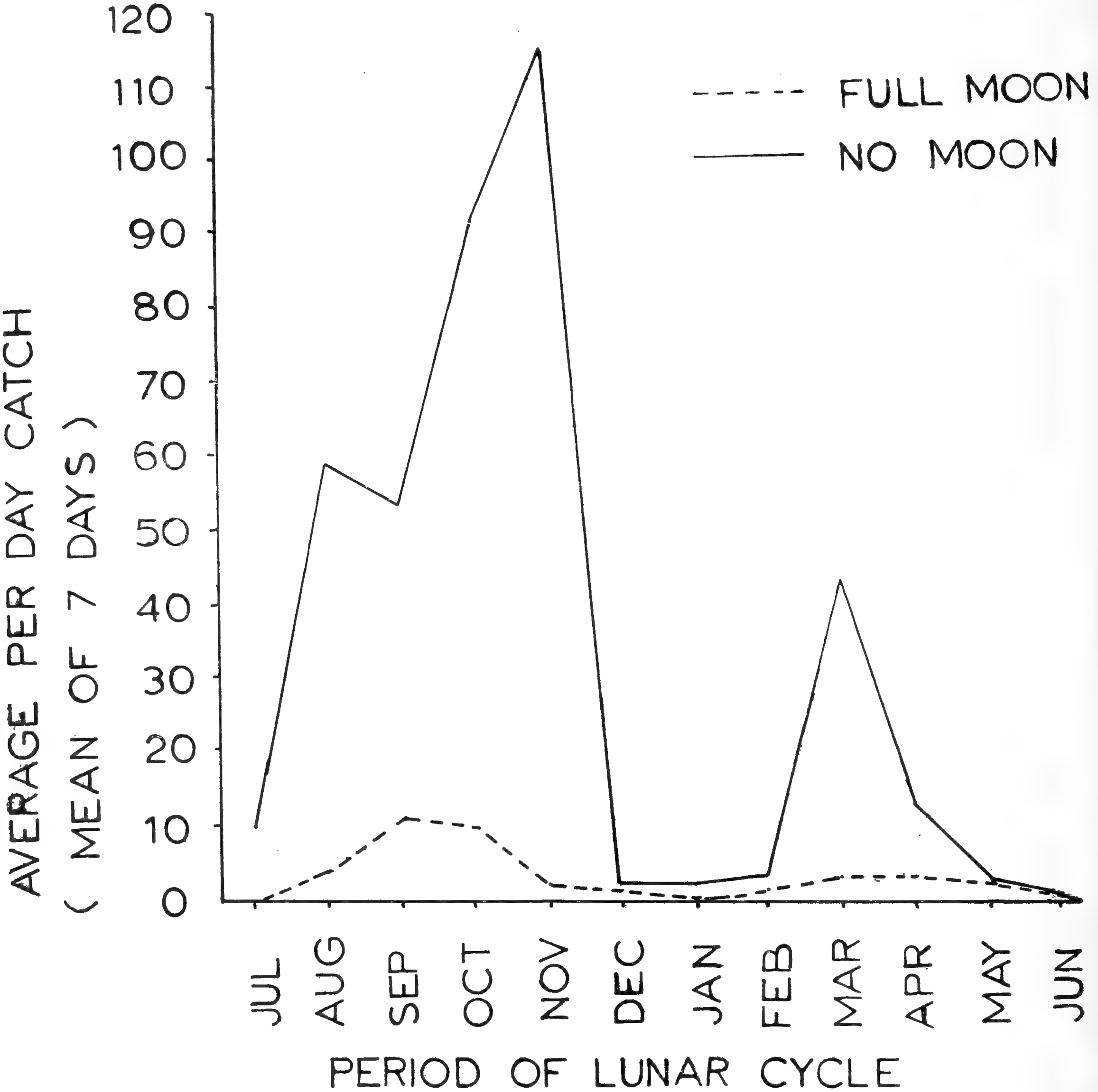

FIG.I

Fig. 1. Effect of moonphase on the light trap catch of *Spodoptera litura* at Jabalpur 1974-75.

0°. With the division of 360° by 15 (days), each day represent a change of 24°, plus or minus depending upon, ascending or descending lunar cycle respectively. Observations were recorded every day. Insects were collected every morning by hand picking and killing in cyanide killing jar. On rare occasions collection was made after 2 days. In such cases, collection was divided half for respective days.

Results and Discussion

At first, the response of moths around the two extremes of lunar phases, i.e. full moon *vs.* no moon, was studied. Average per day collection during ± 3 days around each phase was compared. Data of one complete year corresponding to 12 lunar cycles are presented in Table 1.

Table 1

Effect of moon phase (full moon *vs.* no moon) on the light trap catch of *Spodoptera litura* moths during 1974-75

Lunar Cycle No.	Period of Lunar cycle	Average per day catch of moths	
		Full Moon ± 3 days	No Moon ± 3 days
1.	July 74	0	10
2.	August	3.8	61
3.	September	10.8	53
4.	October	9.8	76.5
5.	Oct-Nov.	1.8	114.8
6.	Nov-Dec.	0.7	2.3
7.	Dec-Jan. 75	0.28	2.0
8.	Jan-Feb	0.57	3.1
9.	Feb-March	2.8	46.0
10.	March-April	2.8	11.7
11.	April-May	1.7	2.14
12.	May-June	0	0.14
Mean of 12 lunar cycles		2.92	31.89

Results clearly show that the light trap catch around 'full moon' was consistently very low as compared to 'no moon' period. Response during 'no moon' period was always very high (Fig. I). Nemec (1971) and Agee *et al.* (1972) also observed such a response with boll worms *Heliothis zea* (Boddie). Brightness of moon light has been observed to be major factor influencing the response.

To investigate whether the response is related to the intensity of moon's light, further analysis was made. The results of correlation and regression analysis clearly indicated the existence of significant negative correlation between the degree of moon phase or intensity of moon light and the light trap catch of moths (Table 2).

Table 2

Effect of lunar cycle and degree of moon phase on the light trap catch of *Spodoptera litura*

S. N.	Degree of noon phase (X)	Average per day catch (Mean of 12 lunar cycle of a year)	
		Ascending lunar cycle (Y_1)	Descending lunar cycle (Y_2)
1.	0	29.83	29.83
2.	24	35.40	25.45
3.	48	34.25	43.41
4.	72	24.92	34.83
5.	96	45.45	17.20
6.	120	17.40	28.50
7.	144	27.50	19.75
8.	168	31.60	15.75
9.	192	45.45	18.33
10.	216	45.00	18.30
11.	240	19.45	14.00
12.	264	27.63	8.58
13.	288	5.08	4.08
14.	312	3.91	1.83
15.	336	2.63	1.08
16.	360	1.66	1.66
Mean		24.82	17.66

't' value 2.483. Significant at 5% level.

Correlation Coeff. } 'r' value –0.672 –0.883

Regression equation $Y_1 = 43.19 + (-0.098\times)$

$Y_2 = 36.83 + (-0.1\times)$

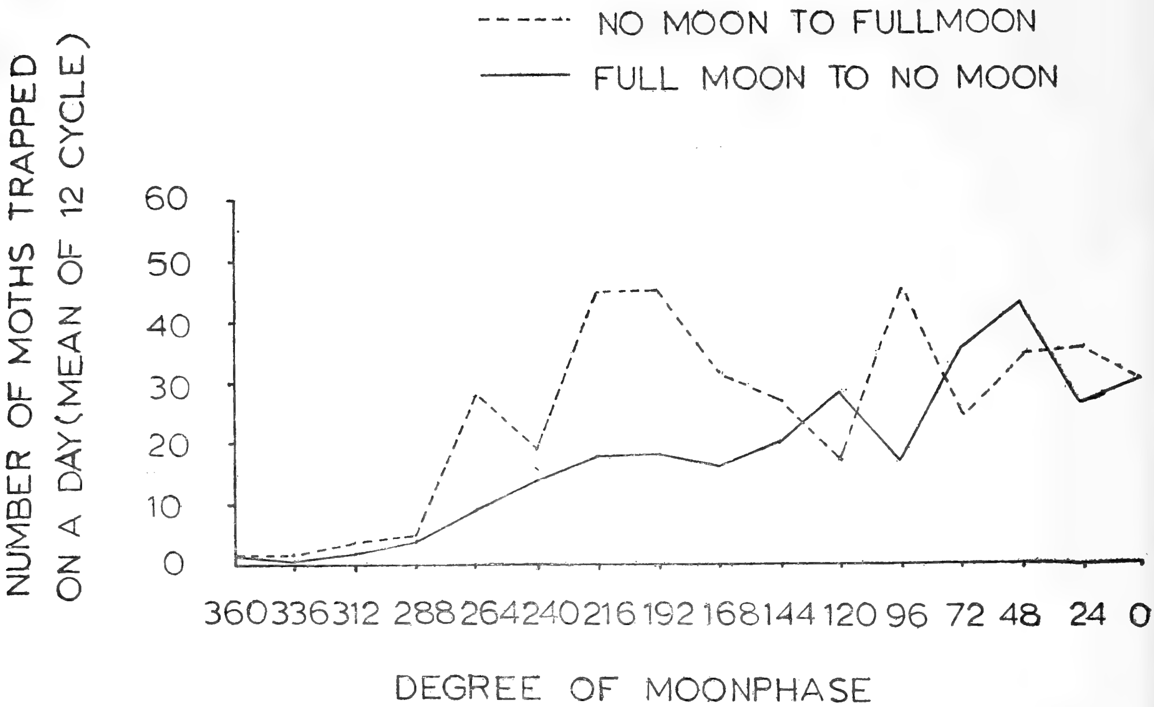

FIG. II

Fig. 2. Effect of lunar cycle and moonphase on the light trap catch of *Spodoptera litura* at Jabalpur 1974-75

Regression analysis showed a linear relationship between the two variables. Correlation was more strong in descending lunar cycle ('r' value – 0.8836) as compared to the ascending lunar cycle ('r' value – 0.672). Nemec (1971) also reported such a linear relationship with *Heliothis zea* but he explained it in general terms.

Further observations revealed a significant difference in the response of moths at the same degree of moon phase in ascending and descending cycle (Table 2). Statistical analysis of data (t value 2.483) and the response curves (Fig. II) reveal that with the same degree of moon's illumination the light trap catch of *S. litura* was always higher in ascending lunar cycle.

Although, the fluctuations in light trap catch in our present observations followed a lunar rhythm, lower during full moon period and higher during no moon period, it may not depend on the intensity of moon light only. Agee *et al.* (1972) pointed out that such a lunar rhythm, in case of *Heliothis zea,* may, depend on the synchronisation of activity and life-cycle of the pest species with the moon phase. He further stated whether moon light *per se* establishes the pattern or whether some physical phenomenon of host plants, temperature, etc. was responsible for this lunar rhythm is not known and should be determined.

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ON THE OCCURRENCE OF "GREENISH-YELLOW WATER" PHENOMENON CAUSED BY THE SWARMING OF *TRICHODESMIUM ERYTHRAEUM* EHRENBURG, IN THE SEA OFF MADRAS AND ITS EFFECT ON THE LOCAL MARINE FAUNA[1]

A. DANIEL, A. K. NAGABHUSHANAM AND P. KRISHNAMURTHY[2]

The phenomenon of coloration of seawater in various shades, ranging from white through red, brown, yellow or green caused by the swarming of a variety of organisms such as Coccolithophores, Blue-green algae, Cystoflagellates, Dinoflagellates and Protozoans is well known (Hart 1934; Hardy 1956). This phenomenon has been reported from all the major oceans of the World, and is often associated with mass mortality, probably caused by its adverse effect on the marine fauna (Galtsoff 1948; Brongersma-Sanders 1957; Raymont 1963; and Panikkar 1967). In Indian waters, the occurrence of this phenomenon caused by the Cyanophyceaen Alga, *Trichodesmium erythraeum* Ehrenburg, has been reported mainly on the west coast of India, Krusadai Island-Pamban area in the Gulf of Mannar and Minicoy Island (Carter 1858, 1863; Hornell & Nayudu 1923; Chacko 1942; Chidambaram 1942; John & Menon 1942; Chidambaram & Unni 1944; Bhimachar & George 1950; Chidambaram & Kurian 1952; Chacko & Mahadevan 1956; Prakash & Sarma 1964; Prabhu *et al.* 1965; Nagabhushanam 1967; and Sudhakar & Doss 1967).

On the east coast of India bordering the Bay of Bengal, excepting for a reference on the occurrence of a 'bloom' of *Trichodesmium* for eleven days during March 1965, in Porto Novo waters by Ramamurthy & Seshadri (1966), there appears to be no published records on the occurrence of any type of coloration of seawater caused by the blooming of any coloured plant, flagellate or protozoan. Therefore, it was considered worthwhile to report on the occurrence, spatial distribution and the bioconstituents of a greenish-yellow coloration caused by the swarming of the Blue-green alga *Trichodesmium erythraeum* over an extensive region in the nearshore waters off Madras for an extended period of 30 days during March-April, 1976. The opportunity was also utilized to discuss the triggering off (initiation) of the blooming, subsequent development and correlating it with various hydrographical parameters.

During the extensive research cruises of the Research Vessel CHOTA INVESTIGATOR of this Station from August 1974 to date, the swarming of the alga *Trichodesmium erythraeum* was first observed as a feeble greenish-yellow discoloration of the sea on the 20th March, 1976 off Madras. Observations on the hydrological conditions and the bioconstituents of the discoloured areas were made with the aid of reversing water bottles, closing plankton nets, trawls, dredges and an echosounder on

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the R.V. CHOTA INVESTIGATOR during its daily routine cruises for five days in the week. At our request, samples were provided by the mechanized fishing trawlers and 'catamarans' operating in this area, which supplemented the data obtained from R.V. CHOTA INVESTIGATOR.

Data on temperature, pH, salinity, oxygen tension, total phosphorus, inorganic phosphate, nitrate, speed and direction of wind and surface currents and rainfall and air temperature were gathered and compared with the bioconstituents obtained from nets and trawls.

A detailed analysis of the data obtained during the entire period of the bloom revealed that the hydrological conditions, the spatial distribution and the bioconstituents of the greenish-yellow water, enabled the distinguishing of four phases as the swarming intensified, climaxed and then waned, i.e., *Initiative phase,* 20th March to 27th March, 1976; *Ascending phase,* 28th March to 4th April, 1976; *Climacteric phase,* 5th April to 11th April, 1976; *Waning phase,* 12th April to 18th April, 1976. The details of these phases are presented below.

I. **Initiative phase:** 20th March—27th March, 1976:—

Weakly coloured patches of 10-12 metres diameter, on surface, to a depth of one metre and extending from the sea-area off Ennur (at least) in the north to entrance of Madras Harbour in the south, and from shore to the 30 metre isobath. Closing net hauls constituted mainly of *Trichodesmium erythraeum* (200-250 filaments per ml of seawater), along with insignificant numbers of phyto- and zoo-plankton, listed below:

Phytoplankters:	Bacillariophyceae	:	*Chaetoceros* sp., *Rhizosolenia* sp., *Navicula* sp., *Nitzschia* sp.
	Dinoflagellata	:	*Peridinium* sp., in small numbers.
Zooplankters:	Coelenterata		
	Scyphomedusae	:	*Cyanea* sp., *Rhizostoma* sp., *Acromitus flagellatus* (Haeckel)
	Hydromedusae	:	*Aequora* sp. (*?pensile*)
	Ctenophora	:	*Pleurobrachia globosa* (Moser)
	Crustacea	:	Mysids, shrimp larvae, prawn larvae, copepods, Cladocera.

Trawl hauls made below these patches yielded very few benthic forms including fish; showing thereby that despite the fact that the high concentrations of *Trichodesmium* occurred only at the surface—one metre depth zone—yet its effect appeared to be felt far below the surface.

Hydrographical data: Temperature (surface) 28.20°C; salinity 33.32°/oo; pH, 8.10; dissolved oxygen, 3.9 ml/1; total phosphorus, 0.7/μ gm at p/1; inorganic phosphate, 0.4/μ gm at p/1; nitrate (NO_2N:mg/1), 0.0019. Current (surface): southerly directed, 2 knots.

Meteorological data: No rainfall over the area. Wind set chiefly from NE towards SW; with light breeze from land to sea in mornings, and sea to land in evenings each day. Air temperature Max.: 34°C, Min.: 22°C. Sky, mostly clear. No fog.

Remarks: No fish or other marine life mortality was observed by us, or reported from

this or surrounding areas, as a result of this bloom. However, there was evidence that fish, prawns, shellfish, and other marine organisms seemed to avoid the bloom area, as the mechanized trawlers and catamarans reported that their catches were falling low in this area.

II. **Ascending phase:** 28th March—4th April, 1976:—

The sea now distinctly greenish-yellow, with grey, gritty matter floating on the surface; faint musty odour over the area. The patches now extended from off Ennur to beyond the New Lighthouse on the Marina, from the surface to near the seabed (in depths less than 5 metres) and from the shore to the 60 metre isobath; each patch measuring 30-50 metres in diameter, with clear water between the patches very narrow. Closing net hauls containing higher concentrations of *Trichodesmium*, and filament counts of bloom samples giving a density of 300-350 filaments per ml of seawater; vertically the bloom was in discrete layers: one layer from surface to 2 metres; another, from 6-7 metres; and (in the 60-metre isobath region) a third layer from 12-15 metre depth-range. Other phyto- and zoo-plankton components, very rare, consisting of:

Phytoplankters:	Bacillariophyceae	:	*Chaetoceros* sp., *Rhizosolenia* sp.
Zooplankters:	Scyphomedusae	:	*Rhizostoma* sp., *Acromitus flagellatus.*
	Crustacea	:	Mysids, copepods.

Trawl hauls made in the area yielded only the two species of medusae mentioned above, and few fish (*Therapon* sp., *Tetradon* sp.).

Hydrographical data: Temperature (surface) 28.20°C, at 60 metre depth 27.65°C; salinity 33.32°/oo; pH, 8.05; dissolved oxygen, 3.2 ml/1; total phosphorus, 11.2/μ gm at p/1; inorganic phosphate, nil; nitrate (NO_2N: mg/1), 0.0002; Current (surface), southerly directed 2-2½ knots.

Meteorological data: No rainfall over the area. Wind set chiefly from NE towards SW; light breeze from land to sea in mornings, and sea to land in evenings, each day. Air temperature Max.: 34°C; Min.: 25°C. Sky, mostly clear. No fog.

Remarks: No fish or other marine life mortality as a result of this bloom was observed, or reported from this area or surrounding areas. Mechanized trawlers and catamarans reported practically no catch from this area. The analysis of the floating grey, gritty matter revealed bundles of thousands of filaments of *Trichodesmium* stuck together.

III. **Climacteric phase:** 5th April to 11th April, 1976:—

The sea still discoloured; no discrete patches observed; entire area uniformly greenish-yellow as viewed from surface; sheets of gritty matter floating on the surface, strong iodoform odour over the area. Concentration of the alga: 400-450 filaments per ml of seawater; the Secchi disc disappeared at 5-metre depth. The sea-area from off Ennur in the north to off Tiruvanmiyur in the south, at least, affected by the bloom. Mechanized trawlers and catamarans reported extension of coloured water from beyond Pulicat in the north to beyond Kalpakkam in the south. Our observations showed that the sea-areas from the shore to the 60-metre isobath was exhibiting the bloom. Closing water bottle samples

revealed that there was heavy concentration -450 filaments per ml of seawater- at the 10-15 metre depth-range in deeper waters, i.e., beyond the 30-metre isobath, and from surface to seabed in lesser depths. Closing net hauls contained *Trichodesmium* filaments almost to the entire exclusion of all other phyto- and zoo-plankters, as evidenced from study of samples taken at various stations and depths in the affected area; thus, the stratification observed earlier in the 'Ascending' phase seemed to have disappeared.

Trawl hauls made in the area yielded only a few large medusae (*Rhizostoma* sp.); no fish were taken. Trawl net fibres coated with gritty slime which when scraped and examined, revealed *Trichodesmium* in large numbers.

Hydrographical data: Temperature (surface) 28.25°C, at 60-metre depth 27.55°C; salinity 33.25°/oo at surface, 33.45°/oo at 60 metre depth; pH, 8.0 at surface; dissolved oxygen 3.1 ml/1; total phosphorus 11.5/μ gm at p/1; inorganic phosphate, nil; nitrate (NO_2N: mg/1), 0.0001; Current (surface), southerly directed, 2-3 knots.

Meteorological data: No rainfall over area. Wind set chiefly from NNE towards WSW; light breeze from land to sea in mornings, and from sea to land in evenings, each day. Air temperature Max.: 34°C; Min.: 25°C. Sky, mostly clear, sometimes with light fleecy clouds. No fog.

Remarks: No mortality of marine life occurred in the area; mechanized trawlers and catamarans reported practically no catch from this and surrounding areas. The sheets of floating grey, gritty matter, when analysed revealed mostly living filaments of *Trichodesmium* in bundles; interspersed were decomposing filaments.

IV. **Waning phase:** 12th April to 18th April, 1976:—

Large patchy sea areas of feebly discoloured seawater, clear stretches in between the patches eroding deeply into the patches. Closing net hauls showed progressive drop in concentration of alga:— 12th April: 400 filaments/ml, 17th April: 200 filaments/ml. On 17th April along with the *Trichodesmium* few copepods, mysids, shrimp larvae, ctenophores and hydromedusae occurred in the samples from most of the area under study. Plankton hauls made on 19th April showed only traces of *Trichodesmium* (20-25 filaments/ml) in the area, and were chiefly made up of copepods, mysids, fish post larvae, ctenophores and hydromedusae.

Trawl and gillnet catches were reported picking up steadily throughout the area from 20th April onwards.

Hydrographical data: Temperature (surface) 28.6°C, at 60-metre depth 27.30°C; salinity (surface) 33.2°/oo, 60 metre depth 33.35°/oo; pH (Surface) 8.10 on 13.4.76, 8.05 on 17.4.76; dissolved oxygen 2.8 ml/1 on 13th, and 2.6 ml/1 on 17th; total phosphor 10.5/μ gm at p/1 on 13th, and 1.4/μ gm at p/1 on 17th; inorganic phosphate, nil on 13th, and 0.3/μ gm at p/1 on 17th; nitrate (NO_2N: mg/1) 0.0015 on 13th, increasing to 0.0019 on 17th April. Current (surface), southerly directed, 2-3 knots.

Meteorological data: No rainfall over area. Wind set chiefly from NE to SW; light breeze from land to sea in mornings, and from sea to land in evenings, each day. Air temperature Max.: 34°C; Min.: 25°C. Sky mostly clear. No fog.

Remarks: No mortality of marine life

occurred in the area; mechanized trawlers and catamarans reported practically no catches from the area upto 18th April, however from 20th April onwards the catches were reported picking up all over the area. The sheets of floating grey, gritty matter on analysis proved to consist chiefly of a mass of dead and putrefying *Trichodesmium* filaments, with very few living filaments interspersed through the mass. The putrefying algal filaments were found to harbour both *gram*-positive and *gram*- negative groups of marine bacteria.

General remarks

A comparison of the hydrographical data obtained during the different dates reveal that there is no significant difference in the temperature, pH, salinity and surface currents; and the meteorological data, i.e., speed and direction of wind, rainfall and air temperature, similarly did not show much variation. Data on dissolved oxygen, total phosphorus, inorganic phosphate and nitrate concentrations exhibit interesting correlation with the different phases of the *Trichodesmium* bloom. These are discussed:

Dissolved oxygen: Data on dissolved oxygen values show that there is a depletion of oxygen with the increase of the bloom, and the lowest oxygen values occur during the waning phase of the bloom. Similar low oxygen values obtained by previous workers during the peak and waning phases of mono-specific blooms causing coloured water phenomena have been attributed to (i) the upwelling of oxygen-depleted water in these zones (*vide* Panikkar 1967); and (ii) the mass decay of 'red plankton' which was aggravated by the release of decay products (Grindley & Taylor 1962). In the Madras inshore waters, where upwelling is not known to take place, the first explanation may not be suitable. Therefore, the depletion of the oxygen during the peak period of the bloom in Madras inshore waters can be attributed to the increased oxygen demand of the rapidly reproducing asexual, non-motile spores and homogenes of the alga. The lowest oxygen values occurring during the waning phase of the bloom is probably due to the bloom formation being followed by an upsurge of marine bacteria, which thrive in the putrefying algal bloom. This ultimately results in the breakdown of the algal mass and in an aggravated deficiency condition of the oxygen content in the seawater. The putrefying algal filaments harbouring *gram*-positive and *gram*-negative groups of marine bacteria during the waning phase of the bloom (*vide supra*), lend support to this view.

Total phosphorus—inorganic phosphate: A comparison of the total phosphorus—inorganic phosphate data with the development of the bloom shows that (i) at the beginning of the bloom, the inorganic phosphate in the seawater declined while the total phosphorus increased gradually; (ii) at the peak of the bloom, the inorganic phosphate was reduced to Zero Value and the total phosphorus increased to the maximum; and (iii) as the bloom waned, the total phosphorus also declined considerably and the inorganic phosphate reappeared. These results support the view that the intensification of the bloom involves the utilization of inorganic phosphate and its conversion to the organic form (Ramamurthy & Seshadri 1966). The reappearance of inorganic phosphate during the waning period of the bloom would suggest that this is one of the parameters regulating the development of the bloom.

Nitrates: Nitrate values were found to decrease with the strengthening of the bloom, reaching low values at the climacterization of the bloom; increasing to normal concentrations

with the disapperarnce of the bloom. These results suggest that during *Trichodesmium* blooming nitrate concentration was depleted to trace values, which is attributable to the utilization of the nitrates during the swarming period. Similar depletion of nitrate to almost zero value with diatom-outburst has been observed by earlier workers, and it has been suggested to regulate the diatom-outburst [Raymond 1963, quoting Harvey (1923), off the New South Wales coast].

Possibly, further work will confirm that the waning of the bloom commences when the inorganic phosphate and nitrate values of the sea-area fall to almost zero value.

However, it must be remembered that the nitrate concentration in the coastal waters of a tropical environment like that of Madras is generally very low and the fluctuations of maximum and minimum values as a result of *Trichodesmium* bloom are correspondingly minimal. Further, the results of culture experiments on nitrogen fixation by *Trichodesmium erythraeum* conducted by Ramamurthy & Krishnamurthy (1968) indicating that this alga can fix free nitrogen in addition to utilizing combind nitrogen, would suggest that when nitrate concentration of seawater falls to zero value the organisms at the interface zone tend to fix atmospheric nitrogen. This may explain the occurrence of vast floating sheets of *Trichodesmium* observed during the present study during the ascendment, climacterization and waning phases of the bloom.

It is evident from the above observations that changes in dissolved oxygen, total phosphorus, inorganic phosphate and nitrate concentrations of the seawater are affected during the different phases of the bloom, and these in turn appear to regulate the algal out-burst. However, the precise mechanism which influences the triggering-off (initiation) of the bloom is not clear. The causative factors contributing to the initiation of such heavy and sudden algal blooms have been attributed to (i) sudden dilution of salinity in coastal waters by addition of freshwater as drain-off from land during heavy rains; (ii) the addition of large quantities of nutrients either by upwelled oxygen-depleted water or by land-drainage; and (iii) the possibility in sudden increase of certain external metabolites or growth factors due to the presence and interaction of micro-organisms and phyto- and zoo-plankton constituents promoting an increase in cell-division (collated from references listed—see Raymont 1963, for details of external metabolites or growth-factors). During the present observations there was no dilution of salinity; additions of large quantities of nutrients by upwelling and/or land-drainage will have to be excluded, since there was no rainfall over the area during the entire period of observations and for some months previous to it, and no large rivers open into this zone; further, upwelling of water masses have not so far been established for this area; there was no difference in the limited land-drainage in the entire zone preceding or during the bloom period. Thus the possibility of increased nutrients by either of these two mechanisms, namely, upwelling or land-drainage, is excluded. It is, therefore, probable that increase in certain external metabolites or growth factors, caused by the presence and interaction of micro-organisms and other phyto- and zoo-plankters, has resulted in the promotion of the rate of cell-division of *Trichodesmium* contributing to the initiation of this vast mono-specific bloom.

Ill-effects of this bloom on marine life: Mass mortality of marine animals has often been associated with the occurrence of coloured water by the swarming of coloured plants,

flagellates and Protozoans from all the major oceans of the world (Brongersma-Sanders 1957; Grindley & Taylor 1962). Previous reports of such mass mortality of marine fauna have also been correlated to the occurrence of heavy *Trichodesmium* blooms from the west coast of India, Krusadai Island and Pamban areas (Chacko 1942; Sudhakar & Doss 1967). Other records in the same region and from Minicoy Island (Arabian Sea) and from Porto Novo (East coast) have recorded the absence of free-moving marine fauna in the 'blooming' areas, although no mass mortality was observed (Prabhu *et al.* 1965; Nagabhushanam 1967; Ramamurthy & Seshadri 1966). This mass mortality reported by earlier workers has been attributed to the planktonic blooms producing potent toxins and/or of direct influence of oxygen depleted water (Prakash & Sarma 1964; Panikkar 1967). During the present study, no fish or other marine life mortality as a result of this bloom was observed or reported from this area or from surrounding areas. There was evidence that free-moving marine organisms avoided the bloom areas as the mechanized trawlers and catamarans also reported that there was practically no catch from this and surrounding areas. It is therefore inferred that the free-moving marine organisms—mainly gill-breathers—avoided this area due to (i) *Trichodesmium* filaments choking or damaging their gills and (ii) depletion of oxygen values as a result of increased oxygen demand of the reproducing algae. It is probable that when these blooms develop gradually, the marine animals are able to avoid such infested zones well in time. Mass mortality probably occurs during heavy and sudden blooming, when the animals are unable to escape from the infested zone. It may also be mentioned that some of the animals in the food-chain may feed on this bloom algae during the initiation phase, and though they may not be directly affected they may act as accumulators of the toxic or poisonous substances produced by the algae; when the bigger animals eat these, it proves fatal and mass mortality may have occurred due to the poisoning effect.

It is clear from the observation described here, and an analysis of the factors suggested as influencing the initiation, development and waning of the algal bloom, that (i) certain external metabolites due to the presence and interaction of micro-organisms, particularly bacteria, play an important part in the initiation of the bloom; (ii) the waning of the bloom commences when the inorganic phosphate and nitrate values of the sea fall to almost zero value, and the oxygen tension is lowered to minimal value; and (iii) the marine organisms avoid the affected area due to choking or damaging of their gills and depletion of oxygen values. Further investigations on the factors influencing the occurrence and spatial distribution of coloration of seawater and their bioconstituents especially the micro-organisms releasing metabolites are required, so that some method of controlling such blooms may be devised with a view to prevent losses to the fisheries of the affected region.

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BREEDING HABITS AND ASSOCIATED PHENOMENA IN SOME INDIAN BATS

PART IV—*HIPPOSIDEROS FULVUS FULVUS* (GRAY)—HIPPOSIDERIDAE[1]

A. MADHAVAN, D. R. PATIL AND A. GOPALAKRISHNA[2]

(*With two plates*)

The breeding biology of *Hipposideros fulvus fulvus* has been described based on the examination of 624 specimens collected at and around Nanded in Marathwada, Maharashtra State. The specimens were collected at frequent intervals during a period of two years from September 1964 to October 1966. This species has a strict sexual periodicity. Copulation, followed by ovulation fertilization and pregnancy occurs in the middle of November. All deliveries in the colony occur within a short span of about two weeks between the last week of April and the first week of May. Gestation lasts for about 150 to 160 days. A single young is delivered by each female during each cycle. The left side of the female genitalia is physiologically dominant, and ovulation and pregnancy occur in the left side of the genitalia more than in the right. The young are carried by the mothers at their breast continuously for 20 to 22 days during which period the young ones grow rapidly. Sexual maturity is not attained by either sex until the animals are at least 18 to 19 months of age. There is an uneven female-dominant sex ratio in the adult stage.

MATERIAL AND METHODS

The specimens of *Hipposideros fulvus fulvus* were collected at and around Nanded, Marathwada region, Maharashtra State, India. The collection was started on 29th September 1964 and continued until 17th October 1966 in such a manner that every calendar month is represented by one collection or more. During the breeding season as many collections as possible were made with a view to obtaining closely graded developmental stages and to arriving at an accurate pregnancy record. Altogether 624 specimens were examined for the present report.

Hipposideros fulvus fulvus is a small bat which is found in underground food cellars and dark recesses of old houses and dilapidated buildings. The specimens were collected at random with the help of butterfly nets. They were killed by chloroform and their body weights were taken, and, in the majority of cases, the length of the forearm, ear pinna, head and left wing were also recorded. After recording observations on the disposition of the external genitalia, teats, position of the testes and other genital organs, the reproductive organs and the accessory reproductive structures in both the sexes were dissected out and fixed in various fixatives such as Bouin's fluid, Carnoy's fluid and neutral formalin. After 24 hours of fixation the tissues were transferred to 70% ethanol, in which they were preserved. The weight of the right testis of all the males was recorded after fixation and preservation in 70% ethanol. Further processing of the tissues for preparing stained sections was carried out as detailed in the previous parts of these studies.

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The group of specimens collected on a given calendar date presented almost the same condition during the two years when the observations were made. Hence, in the following descriptions only the date and the month are mentioned where pertinent, except where the mention of the year has a special significance.

A detailed collection diary giving the salient characters of each specimen was maintained. Table I gives the summary of the collection diary and Table II gives the monthwise collection of the specimens.

TABLE I

SUMMARY OF COLLECTION DIARY

Date	Males				Females							Grand total
	Immature		Adult		Immature		Adult					
	Attached to mother	Free		Total of males	Attached to mother	Free	Non-pregnant	Pregnant: Right horn	Pregnant: Left horn	Lactating	Total of females	
1	2	3	4	5	6	7	8	9	10	11	12	13
1-1-65	—	—	—	—	—	—	—	—	2	—	2	2
2-1-65	—	—	3	3	—	—	—	1	1	—	2	5
12-1-65	—	—	1	1	—	—	—	—	1	—	1	2
15-1-65	—	1	7	8	—	—	4	5	7	—	16	24
20-1-65	—	—	3	3	—	—	1	1	9	—	11	14
21-1-66	—	—	—	—	—	—	—	3	4	—	7	7
28-1-65	—	—	1	1	—	—	—	—	3	—	3	4
1-2-65	—	—	—	—	—	—	—	1	1	—	2	2
9-2-65	—	—	4	4	—	—	—	—	2	—	2	6
17-2-66	—	—	1	1	—	—	—	2	4	—	6	7
27-2-66	—	—	—	—	—	—	—	1	—	—	1	1
9-3-65	—	—	—	—	—	—	—	—	4	—	4	4
12-3-66	—	—	1	1	—	—	—	1	—	—	1	2
15-3-65	—	1	—	1	—	—	1	1	7	—	9	10
18-3-65	—	—	2	2	—	—	—	5	8	—	13	15
23-3-65	—	—	—	—	—	—	—	4	5	—	9	9
26-3-65	—	—	2	2	—	—	—	4	8	—	12	14
23-4-65	1	—	1	2	—	6	—	—	1	1	2	4
25-4-66	2	—	—	2	2	—	—	2	—	4	8	10
26-4-65	1	—	3	4	1	—	—	—	6	3	10	14
7-5-65	3	—	2	5	6	—	—	—	—	11	17	22
11-5-65	2	1	3	6	3	4	—	—	—	10	17	23
16-5-66	3	—	1	4	2	—	1	—	—	7	10	14
19-5-65	6	5	5	16	9	8	—	—	—	26	43	59
25-5-65	—	10	5	15	—	13	—	—	—	9	22	37
26-5-66	1	4	—	5	1	3	—	—	—	11	15	20
5-6-65	—	—	13	13	—	1	—	—	—	3	4	17
15-6-66	—	1	2	3	—	8	2	—	—	10	20	23
16-6-65	—	4	2	6	—	4	—	—	—	6	10	16
29-6-65	—	—	1	1	—	1	4	—	—	5	10	11
12-7-65	—	1	—	1	—	1	—	—	—	—	1	2

Table I (*Continued*)

	Males				Females							
	Immature		Adult		Immature		Adult					
								Pregnant				
Date	Attached to mother	Free		Total of males	Attached to mother	Free	Non-pregnant	Right horn	Left horn	Lactating	Total of females	Grand total
1	2	3	4	5	6	7	8	9	10	11	12	13
14-7-65	—	—	9	9	—	—	3	—	—	—	3	12
1-8-65	—	—	3	3	—	—	16	—	—	—	16	19
11-8-65	—	1	1	2	—	1	13	—	—	—	14	16
11-8-66	—	—	5	5	—	—	4	—	—	—	4	9
28-8-65	—	—	2	2	—	—	3	—	—	—	3	5
10-9-65	—	—	5	5	—	2	—	—	—	—	2	7
10-9-66	—	—	—	—	—	—	3	—	—	—	3	3
29-9-64	—	—	4	4	—	—	7	—	—	—	7	11
29-9-65	—	—	1	1	—	—	1	—	—	—	1	2
1-10-65	—	—	2	2	—	—	8	—	—	—	8	10
8-10-65	—	—	4	4	—	—	1	—	—	—	1	5
11-10-64	—	6	7	13	—	—	9	—	—	—	9	22
17-10-66	—	—	1	1	—	1	10	—	—	—	11	12
28-10-64	—	9	3	12	—	—	10	—	—	—	10	22
13-11-65	—	—	—	—	—	—	4	—	—	—	4	4
15-11-65	—	—	3	3	—	—	—	—	—	—	—	3
16-11-64	—	—	6	6	—	—	5	—	—	—	5	11
22-11-65	—	—	7	7	—	1	—	—	3	—	4	11
28-11-64	—	—	3	3	—	—	7	—	—	—	7	10
6-12-65	—	—	1	1	—	—	—	2	1	—	3	4
10-12-64	—	3	1	4	—	1	—	—	—	—	1	5
16-12-64	—	—	—	—	—	—	1	—	—	—	1	1
17-12-64	—	1	1	2	—	—	1	4	2	—	7	9
20-12-65	—	—	2	2	—	—	1	—	1	—	2	4
28-12-64	—	—	3	3	—	—	—	1	3	—	4	7

Table II

Monthwise collection of specimens

Month	Males	Females	Total
Jan.	16	42	58
Feb.	5	11	16
Mar.	6	48	54
Apr.	8	20	28
May	51	124	175
Jun.	23	44	67
Jul.	10	4	14
Aug.	12	37	49
Sep.	10	13	23
Oct.	32	39	71
Nov.	19	20	39
Dec.	12	18	30
Grand total	204	420	624

Observations and conclusions

1. General remarks on *Hipposideros fulvus fulvus.*

Hipposideros fulvus fulvus is a small bat, the maximum weight of the male and of the non-pregnant female being about 10 gm. The other maximum measurements are as follows: wing span—13 cm in both sexes; forearm—4.2 cm in both sexes; ear pinna—2 cm in female and 2.1 cm in male; head length—2.3 cm in female and 2.5 cm in male. The fur on the dorsal side is dark grey and that on the ventral side is immaculate or greyish white. This species chooses dark, cool and damp

places for roosting in such a way that a water tap or a shallow well and a shady tree are present in the vicinity of the cellar so that the roosting place gets as much moisture and shade as possible. It is very seldom that these animals emit an audible sound, but the presence of a colony of *Hipposideros fulvus fulvus* is easily detected by a characteristic odour. They are very active and swiftly fly away if there is even a slight disturbance. In the resting position they remain freely suspended from the ceiling. The specimens roost isolated and free from one another and are never seen in clusters (fig. 1). While they are in the resting position, they show constant movements by swinging their bodies, moving their heads in a rotary motion, flapping their wings and often changing their position in the colony. A colony usually has about 50 to 100 specimens. They leave their underground cellars late in the evening for feeding. On several occasions, when the roosts were visited at about 11 O' clock in the night, the specimens were still found flying about in the cellar, but not flying out of the cellar. Dead bodies of cockroaches and of beetles were often found in the cellars where these animals live. Males and females are found in the same colony irrespective of the age of the animals or the season. If the roost is visited frequently for collection of the specimens the bats leave the roost and do not return to the same roost for several weeks.

Attempts to keep them alive in the laboratory were not successful as the animals are very delicate and do not survive in captivity under normal humidity. However, the specimens survive for a day or two if a wet cloth or a wet pad of cotton is placed in the cage and over the wire mesh of the cage.

The unweaned young ones are found to be attached to the mothers in the head-to-tail position during the resting non-sucking times. The young one holds one or some times both the pubic dugs in its mouth, and the hind limbs are kept free, or in a loose embrace, round the neck of the mother. While sucking (fig. 2) the young holds the mammary nipple by the jaws, and the claws of the hind feet are firmly anchored to the pubic dugs. When the young one is able to fly, it remains separated from the mother, but occasionally attaches to one of the mothers in lactation for sucking. Before doing so, it flies towards the mother and clings to a rough surface of the ceiling close to the mother, and, with a sudden swing, gets a hold on the mother's body with the help of the claws in the hind limbs, and then holds the mother's mammary nipple by its jaws. The mother sometimes holds the skin of the back of the young in her mouth to prevent it from slipping down. Apparently, there is community suckling of the young after the young ones get free from the mothers, since it would be impossible for the young one to seek out its own mother in the colony.

2. Female reproductive organs.

The ovary is ellipsoidal in shape measuring about 1 mm long and 0.5 mm broad. The ovarian surface is warty. Each ovary is enclosed by a complete ovarian capsule and is attached to the dorsal ligament by a narrow hilus. The Fallopian tube on each side arises from the medial margin near the caudal end of the ovarian bursa. It takes a tortuous course around about the middle of the ovarian capsule, and bends caudally on the lateral side of the ovarian capsule and open into the respective uterine cornu.

As in all other bats, except in the members of the family Phyllostomatidae, the uterus is bicornuate ,and the two cornua are morphologically symmetrical. Each uterine cornu forms

a twisted arch bulging anteriorly, and is about 8 mm in length. The two cornua meet mesially and their lumina become confluent. There is a common broad cervical canal opening into the vagina. The vagina is about 6 to 7 mm long and opens by a transverse vulval opening.

The mammary glands are pectoral in position and are present on the ventro-lateral aspect of the thorax, one on each side. The mammary nipples, one on each side, are directed laterally. In the parous females there is a pair of prominant pubic dugs without mammary glands in the inguinal region, one on each side.

3. Breeding habits.

The examination of the collection diary and table I reveals some interesting features. Pregnancy occurs only during the months from about the middle of November to about the last week of April. Figures 3-8 are photographs of entire genitalia of many female specimens collected on different dates, and are intended to illustrate the condition of the female reproductive organs during the different months of the year. From the examination of the figures it is evident that progressively advanced stages of pregnancy occur from November to the following April. The above facts indicate that *Hipposideros fulvus fulvus* experiences a single reproductive cycle in the year .

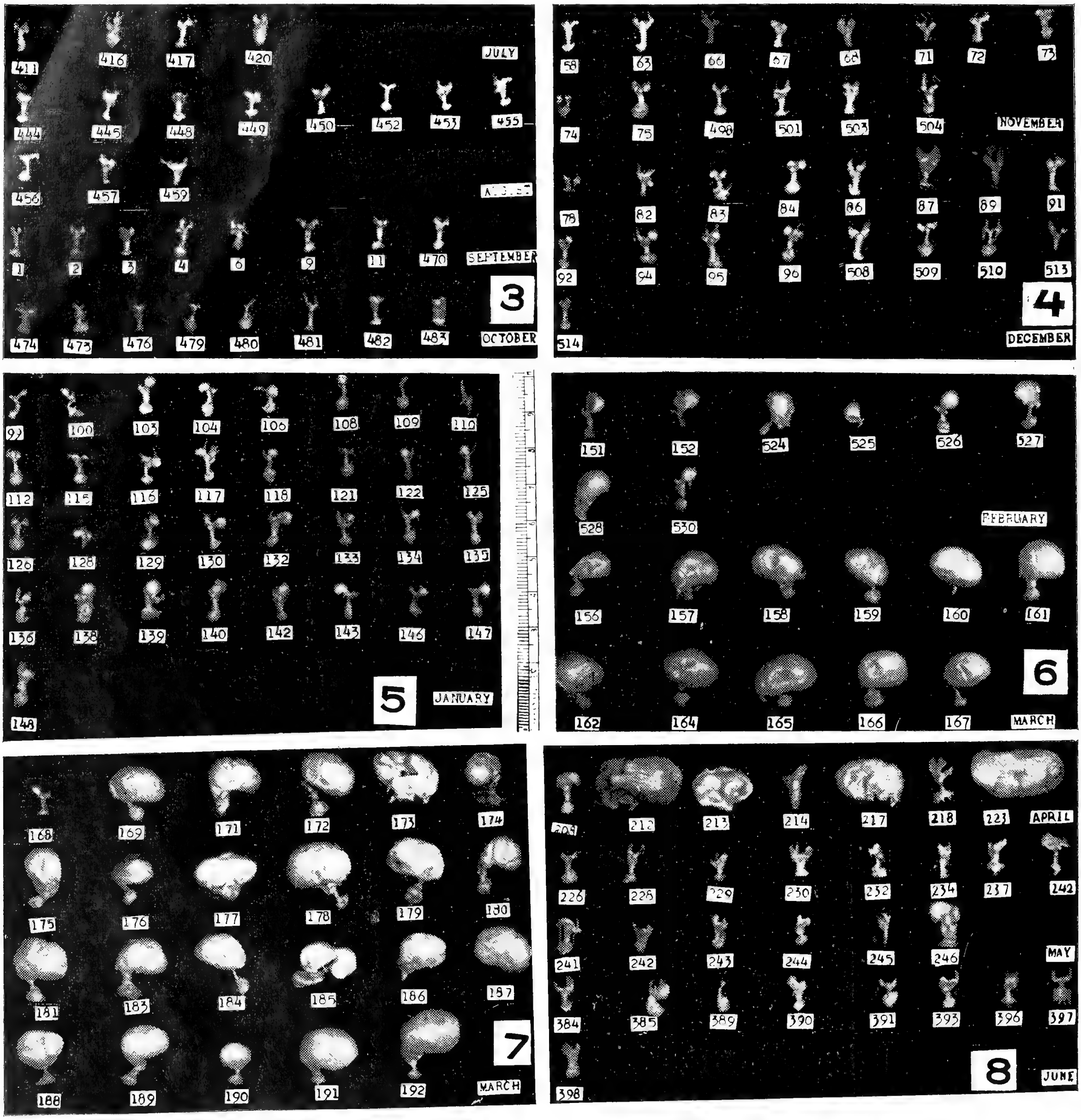
Microscopic examination of the females revealed that copulation had not occurred in the females collected on October 28, but each of the females collected on November 13 had undergone copulation as evidenced by the presence of sperms in their uteri and Fallopian tubes. However, none of them had undergone ovulation, but in each specimen one of the ovaries had a fully formed Graafian follicle which was about to rupture. Of the five females collected on November 16, in four specimens the ovary of one side had an early corpus luteum, and in each of these specimens an egg in early cleavage was present in the Fallopian tube. The remaining female had, in one of the ovaries, a pre-ovulatory Graafian follicle. Each of the adult females collected on November 22 had an early blastocyst. In the females captured on November 28, early stages of implantation were noticed. On any given date during the period from December to April all the pregnant females were practically in the same stage of gestation. The above facts lead to the conclusion that all adult females undergo copulation in a sharply restricted period in about the second week of November after which, within a short time, ovulation and fertilization take place followed by pregnancy.

The first delivered young in the year, and which was a couple of days old, was collected on April 23. All the parous females collected on and after May 7 had delivered their young. Apparently, all deliveries in the colony had taken place within a short span of two weeks —the last week of April and the first week of May.

Females carrying young at the breast were collected from April 23 until May 26. But it is very unlikely that each young is carried by its mother for this duration of time. This is evidenced by the following facts: The heaviest young attached to the mother was 4.5 gm in weight, and the young leave their mothers after they reach this weight. The first batch of the free young ones of about this weight was collected on May 11. Evidently, these must have belonged to the first batch of young ones delivered around April 23. From this it is apparent that the mothers carry their young only for about 20 to 22 days, calculating from the date on which the first delivered young was

Fig. 1. A part of a colony of *Hipposideros fulvus fulvus*. Note the specimens hanging freely from the ceiling and remain isolated from one another without huddling together.

Fig. 2. Photograph of a mother suckling her young. The position of the young is reversed while it is not sucking milk.



Figs. 3-8. Photographs of entire female genitalia of some specimens collected during several months of the year. Note that progressively advanced stages of pregnancy occur from November to April. During the pregnant season there are a few non-pregnant specimens also (Nos. 110, 115, 121, 128, 135, 168) indicating that not all the females become pregnant in the breeding season. Pregnancy is not noticed during the other months.

collected (April 23) to the date on which the first free young was collected (May 11) and allowing a margin of a couple of days. However, even after they leave their mothers the young ones probably visit lactating mothers for sucking for some time more. This is indicated by the facts that curdled milk was present in the stomach of several free young, and the mammary glands of the mothers continue to be in lactation for quite some time after the young ones leave their mothers. Females in lactation were collected until July 29.

From the foregoing account of the breeding habits of *Hipposideros fulvus fulvus* the annual life of the females of this species can be recognized into the following periods:—

(1) Period of sexual inactivity from about the end of June to the beginning of November.
(2) Copulation in the second week of November.
(3) Pregnancy from about the middle of November until about the end of April.
(4) Parturition during the last week of April and the first week of May.
(5) Lactation until the end of June.

4. Gestation.

It has been already mentioned that the females collected on November 13 had not ovulated even though they had undergone copulation. But in some of the females collected on November 16 very early cleavage stages of the egg were present indicating that fertilization might have taken place about a day or two before. The first date on which a delivered young was obtained was April 23, and from the condition of the young it can be presumed that this might have been delivered just a couple of days before. This conclusion is based on the following facts:—the young was completely naked wihout any visible fur; the eye lids were adherent; a withered umbilical cord was still present; it had a body weight of 2.2 gm, which is also the maximum weight of the full term foetus. From the foregoing it is evident that the gestation period of *Hipposideros fulvus fulvus* is about 150 to 160 days, allowing a margin of a couple of days on either side.

5. Growth and maturity.

Mention has already been made that the young are all delivered in a sharply defined period between about April 22 and May 7. The new born young weighs about 2.2 gm (The maximum weight of the foetus in this species is also 2.2 gm). Immediately after birth the young one gets attached to the breast of its mother, and is carried by the mother until it attains a body weight of about 4.5 gm. After the young one reaches this weight it leaves the mother, although it may continue to suck milk occasionally for a few more days as evidenced by the fact that the young specimens weighing more than 4.5 gm were some times noticed in the act of sucking from the breast of mothers during the later half of May. The first batch of free young weighing 4.5 gm was collected on May 11. It has been mentioned that the young is carried continuously by the mother for about 20 to 22 days only. During this period the young one grows from 2.2 to 4.5 gm in weight, that is, it increases about twice in its weight. Mothers carrying young were collected until May 26. After this date it is hardly possible to distinguish the young from the adults on the basis of the size of the body. Evidently, the young one grows very rapidly during the early period, and by the time it leaves its mother it has grown very nearly to the adult size.

In *Hipposideros fulvus fulvus* the size and the nature of the mammary nipples and pubic dugs, taken along with the pregnancy record, can be used as valid criteria for determining the sexual maturity or otherwise in the females. In the non-parous females the mammary nipples and the pubic dugs are very insignificant and are almost not visible. During the first lactation these structures enlarge in size and remain as such throughout the rest of the life. Hence, in all parous females these are conspicuous and large. The collection diary and table I indicate that during the breeding season (that is, from the middle of November until about the end of April) some females with insignificant mammary nipples and pubic dugs were also collected. Among these a few were found to be non-pregnant, and their ovaries presented a histological structure typical of the immature condition. Among the males also a number of immature ones, as revealed by the size and histological structure of the gonads and accessory reproductive organs were collected during the breeding season. The fact that immature ones of both sexes are present during the height of the breeding season strongly suggests that in this species sexual maturity is not attained by either sex in the year of birth. Since the young are born late in April or early in May, and since the sexual season commences in November, the animals take at least 18 to 19 months to reach sexual maturity, calculating from April to November of the following calendar year. However, it is not possible definitely to state that these animals do attain sexual maturity in their second year itself. Thus, at the beginning of the breeding season early in November the females can be recognized into at least three categories:—(i) non-parous juvenile females, (ii) females experiencing their first breeding cycle, and (iii) parous females in their second or subsequent cycles. Category (i) and (ii) have insignificant mammary nipples and pubic dugs. Microscopic examination of the ovaries reveals that, whereas in the females belonging to category (i) the ovaries present a typical immature histology, in the females belonging to category (ii) one of the ovaries has a fully developed Graafian follicle. The females belonging to category (iii) have well developed mammary nipples and pubic dugs.

The adult males do not exhibit spermatogenetic activity from January to about the middle of September. In September the testis seems suddenly to spring into activity, and from about the beginning of October until about the end of December, the testes and the epididymides show abundant sperms, and the accessory glands are active. Although the males are sexually functional for nearly three months, the sharp restriction of the season of copulation is determined exclusively by the female.

6. Sex ratio.

Out of a total of 624 specimens of *Hipposideros fulvus fulvus* collected at random for two successive years, 204 (32.68%) were males and 420 (67.32%) females. 46 young ones collected from the breasts of the mothers included 20 males and 26 females. This small number of juvenile young ones may not warrant a definite conclusion regarding the sex ratio at birth, although the figures may indicate a slightly unbalanced sex ratio even during the juvenile life. But the marked difference in the number of males and females in the total population should reflect the natural sex ratio in this species, since the collections were made at random and since there is no segregation of the sexes.

7. Number of young.

From the collection diary and table I it is evident that pregnancy can occur in either of the uterine cornua in this species. However, out 123 specimens, in which there was unquestionable indication of pregnancy, 37 had pregnancy in the right cornu and 86 in the left. Microscopic examination of the ovaries of the pregnant females revealed that the corpus luteum was present invariably on the same side in which the uterine cornu carried the conceptus. This indicates that there is no transmigration of ova. From the material available at present it is not possible to state if there is any physiological alternation of the two sides of the genitalia in successive cycles. On the other hand it is very unlikely that such alternation of the two sides of the genitalia occurs since in the two successive years, when collections were made, the pregnancies occurred on the left side more than on the right side. For example in 1964-1965, 28 females had pregnancy on the right side and 72 on the left, and in 1965-1966, 9 had the pregnancy on the right side and 14 on the left. If physiological alternation occurred between the two sides of the genitalia, then the proportion of the pregnancies on the two sides should alternate in successive years. Evidently, in this species there is a natural dominance of the left side of the genitalia over the right. The factors responsible for this are not known.

FOOD AND FEEDING HABITS OF *LABEO GONIUS* (HAM.) FROM THE RIVER KALI[1]

A. CHATTERJI, A. Q. SIDDIQUI[2] AND A. A. KHAN

(*With three figures*)

L. gonius (Ham.) feeds mainly on phytoplanktonic organisms. Diatoms, green algae and decayed organic matter were the main food items present in the gut. The presence of sand and mud in the gut contents showed bottom feeding habits of the fish. The intensity of feeding was found to be maximum during post-monsoon and winter months (October-February) and low during post-winter and monsoon months (March-August). Maturation of gonads also adversely affected the feeding intensity in both the sexes. The fish showed a positive selection for all phytoplanktonic organisms.

INTRODUCTION

An important aspect of the biology of fish is to determine its food and feeding habits. Food composition, intensity of feeding and its variations with season, size and sex of *Labeo gonius* are reported here.

MATERIALS AND METHODS

Monthly samples were obtained for a period of 12 months, from January to December, 1974. The fishes were caught by gill net during the early hours of morning and brought to the laboratory in ice.

Each fish was measured upto nearest millimetre from the tip of the snout to the longest ray of caudal fin, weighed nearest to 0.1 gm and sexed. State of maturation was determined following the scheme of classification used for *Ophicephalus punctatus* (Qayyum & Qasim 1964*a*). The guts were taken out carefully from the oesophagus to the last part of the intestine, weighed upto 0.5 gm and preserved in 10% formalin.

For the analysis of gut content of the fishes, the number method as described by Hynes (1950) was followed. As far as possible, various planktonic food items were identified upto generic level and counted. Their relative abundance was expressed as percentage of total number of food items in the sample. The percentages of decayed organic matter and sand and mud were decided by eye estimation.

The intensity of feeding was studied by determining the gastro-somatic index (gut weight expressed as percentage of body weight). The number of fishes with empty guts was also noted in each month and expressed as the percentage of total number of fishes examined in that month.

RESULTS AND DISCUSSION

Absence of teeth, a narrow mouth, depressed buccal cavity, absence of tongue, modification of gill rakers for filtration, absence of stomach and presence of long gut indicated herbivorous feeding habit of this fish. The

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TABLE 1

MONTHLY VARIATIONS IN THE PERCENTAGE COMPOSITION OF DIFFERENT FOOD ITEMS OF *Labeo gonius*

Food items	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
GREEN ALGAE	11.1	6.7	11.2	12.9	15.9	4.5	2.4	5.2	6.8	6.7	8.5	16.9	8.6
Oedogonium	0.6	0.2	0.9	0.4	0.1	—	0.6	—	—	0.2	0.3	0.5	0.5
Pediastrum	0.5	0.1	0.4	0.2	—	—	0.1	0.1	1.0	0.1	0.2	0.4	0.4
Selenastrum	—	—	0.2	—	—	0.1	—	1.3	0.2	0.3	—	0.7	0.5
Ankistrodesmus	2.5	—	0.2	0.3	0.2	0.2	0.1	0.2	1.8	1.1	2.5	4.2	0.8
Senendesmus	1.2	—	0.2	6.9	5.2	1.7	0.9	1.6	2.5	2.1	4.2	5.1	2.0
Spirogyra	3.1	—	5.2	11.3	7.9	2.2	0.8	1.9	0.9	—	0.1	0.8	1.7
Tetraspora	—	5.2	—	—	—	—	—	—	0.1	—	1.2	2.1	0.5
Crucigenia	3.2	1.2	4.1	3.8	2.5	1.3	—	—	—	2.9	—	3.1	2.2
DIATOMS	34.1	21.3	30.1	15.1	5.4	1.7	6.6	9.9	24.0	27.4	32.1	43.4	18.6
Cyclotella	8.2	3.1	0.4	3.5	0.5	0.2	1.9	2.1	4.0	9.5	11.5	11.9	3.3
Diatoma	0.7	3.5	3.1	1.9	1.1	0.1	0.9	1.0	3.1	0.8	0.7	1.1	1.6
Nitzschia	1.3	1.1	1.7	1.5	0.8	0.2	1.8	2.6	2.1	6.2	5.2	4.1	2.2
Navicula	13.1	10.5	11.5	5.2	2.5	0.5	0.8	2.1	4.8	7.8	10.5	12.2	3.9
Cymbella	2.5	0.8	0.5	0.3	0.3	0.1	1.2	2.0	3.8	—	—	0.3	1.9
Gyrosigma	4.5	3.7	2.1	0.9	—	0.2	—	—	2.0	1.9	2.1	8.5	2.3
Cocconeis	3.8	0.5	10.2	0.9	0.2	—	—	—	0.9	1.2	1.8	3.1	1.6
Synedra	—	—	0.4	0.8	—	—	—	0.1	0.5	—	0.2	0.1	0.3
Surirella	—	2.1	0.2	—	—	—	—	—	2.8	—	0.1	0.1	1.5
BLUE GREEN ALGAE	0.4	0.6	0.2	1.6	1.0	—	7.2	4.2	7.7	2.5	2.3	0.3	5.2
Nostoc	—	0.2	—	0.1	—	—	0.9	0.1	0.8	0.3	0.2	0.1	0.5
Anabaena	—	—	0.2	—	—	—	—	—	1.5	—	1.1	—	0.8
Microcystis	—	0.3	—	0.4	0.2	—	3.8	2.0	2.5	—	—	0.2	2.1
Phormidium	0.4	0.1	—	1.1	0.8	—	2.5	2.1	1.9	2.2	1.1	—	1.8
DESMIDS	2.3	4.1	1.7	—	—	—	0.2	1.6	1.5	2.4	4.1	1.2	1.4
Cosmarium	0.2	1.3	1.5	—	—	—	0.2	0.3	0.6	—	—	—	0.3
Closterium	2.1	2.8	0.2	—	—	—	—	1.3	0.7	2.4	0.1	5.2	1.1
Volvox (PHYTO-FLAGELLATES)	0.4	—	—	—	—	—	—	—	0.1	—	0.1	—	0.1
ALGAL SPORES AND ZYGOTES	0.2	—	1.4	1.9	—	2.1	8.2	10.5	14.5	1.2	0.8	0.3	8.5
MACROVEGETATION	2.1	0.9	5.5	4.2	6.2	6.5	6.5	2.0	2.8	3.5	4.1	3.8	3.7
DECAYED ORGANIC MATTER	13.5	22.2	6.2	8.2	6.7	13.2	12.8	16.5	20.2	33.7	28.5	15.5	16.4
Keratella (ROTIFERS)	—	—	0.2	—	—	—	—	2.8	1.5	0.2	—	—	2.1
SAND AND MUD	35.9	45.2	48.5	56.1	64.8	72.0	56.1	47.3	20.9	22.4	19.5	18.6	35.4

analysis of gut contents of the fish for consecutive months showed that the fish mainly feeds on small phytoplankton and decayed organic matter.

Food composition

Seasonal variation in the composition of gut contents of *L. gonius* becomes quite apparent from Table 1. Phytoplankton was found to be the main food of the adult fish. It formed about 45% of the total food consumed.

Diatoms (Bacillariophyceae)

The diatoms were represented by 9 genera which formed the chief food of the fish and constituted about 18.6% of the total food. This group was more abundant in the food items encountered during October to March and comparatively lesser percentage occurred from April to August. The percentage of diatoms was very low in June. *Navicula, Cyclotella, Nitzschia, Gyrosigma, Cymbella* and *Diatoma* were the most important diatoms and occurred in decreasing order. From September to April, *Navicula* was encountered abundantly while from May to August it was extremely scarce. *Nitzschia* was commonly found throughout the year except during May, June and July (Table 1).

Green algae (Chlorophyceae)

In *L. gonius* diet green algae were represented by 8 genera, they constituted about 8.6% of the total food and occurred throughout the year in the gut content. They were more abundant during January, March, April, May and December and less abundant in July. The most important genera were *Scenedesmus, Ankistrodesmus, Crucigenia* and *Tetraspora.* The less important genera were *Oedogonium, Pediastrum, Selenastrum* and *Spirogyra* (Table 1).

Blue green algae (Myxophyceae)

This group, comprising of *Nostoc, Anabaena, Microcystis* and *Phormidium,* formed 5.2% of the total food. *Microcystis* and

TABLE 2

VARIATIONS IN THE FOOD COMPOSITION OF *Labeo gonius* IN RELATION TO SIZE

FOOD ITEMS	SIZE GROUPS II (201-250)	III (251-300)	IV (301-350)	V (351-400)	VI (401-450)
Green Algae	16.7	10.1	10.4	8.7	10.2
Diatoms	29.5	31.3	31.4	8.6	3.7
Blue Green Algae	0.4	1.2	0.9	1.6	1.0
Desmids	1.2	2.5	2.5	—	—
Phytoflagellates	0.3	0.3	1.2	2.1	2.2
Algal spores & zygotes	1.7	0.7	1.4	1.9	—
Macrovegetation	3.9	2.5	2.4	5.3	6.4
Decayed organic matter	14.5	19.7	19.9	10.7	10.5
Rotifers	—	0.2	0.2	—	—
Sand and mud	31.8	31.5	29.7	61.1	66.0

The percentage of food items in the gut contents of the fishes of size group I (150-200) could not be studied as the specimens of this size group were not available in sufficient number.

Phormidium were more common. Myxophyceae was predominant in July and September.

Other food items

Desmids, phytoflagellates, algal spores and zygotes and macrovegetation were also encountered in the guts of *L. gonius* (Table 1). These items together formed 13.7% of the total food. Zooplankton occurred in very small quantities and appear to have accidentally entered along with phytoplankton.

Decayed organic matter

This group mainly consisted of unidentifiable plant matter in decayed condition and constituted about 16.4% of the total food. It occurred regularly in the gut throughout the year.

Sand and mud

It formed 35.4% of the total food and occurred in the gut throughout the year and constituted the main bulk of the gut contents (Table 1).

A gradual increase in the percentage of phytoplankton along with sand and mud in the gut contents with increase in size of the fish reveals that this species changes its feeding habit as it grows (Table 2, Fig. 1). The occurrence of large quantities of decayed organic matter together with sand and mud in the gut indicates that the fish feeds at the bottom.

No difference was noted in food composition of males and females.

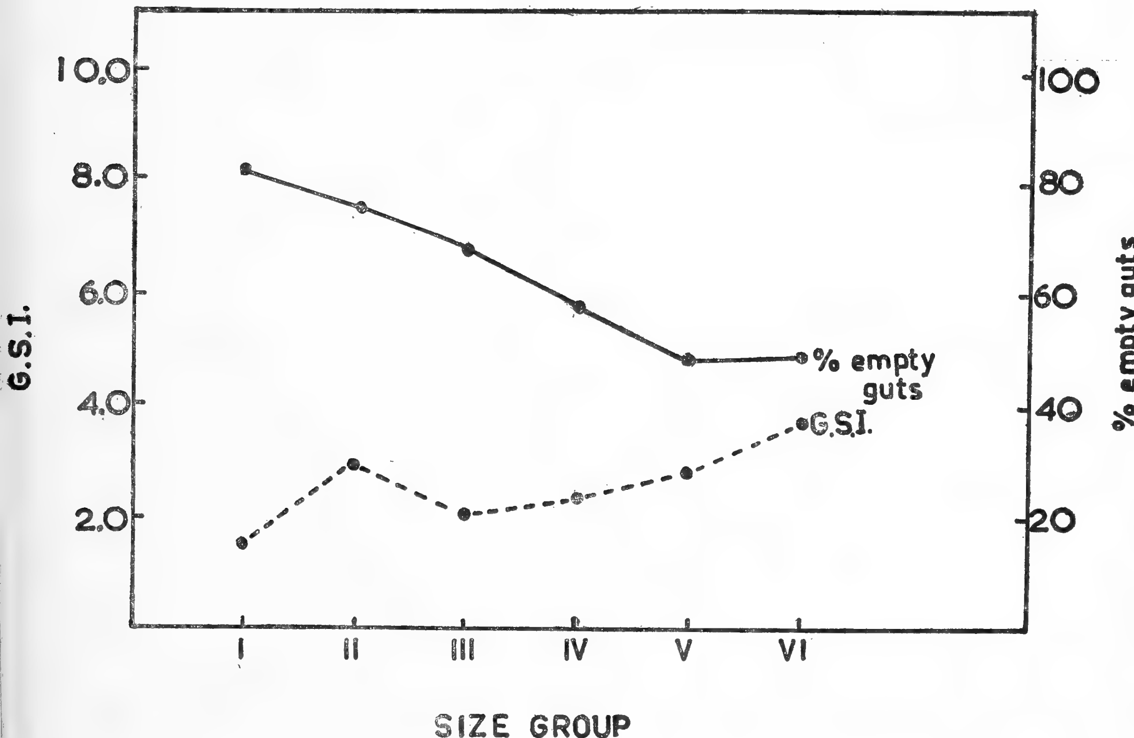

Fig. 1. Intensity of feeding at different size groups of *L. gonius*.

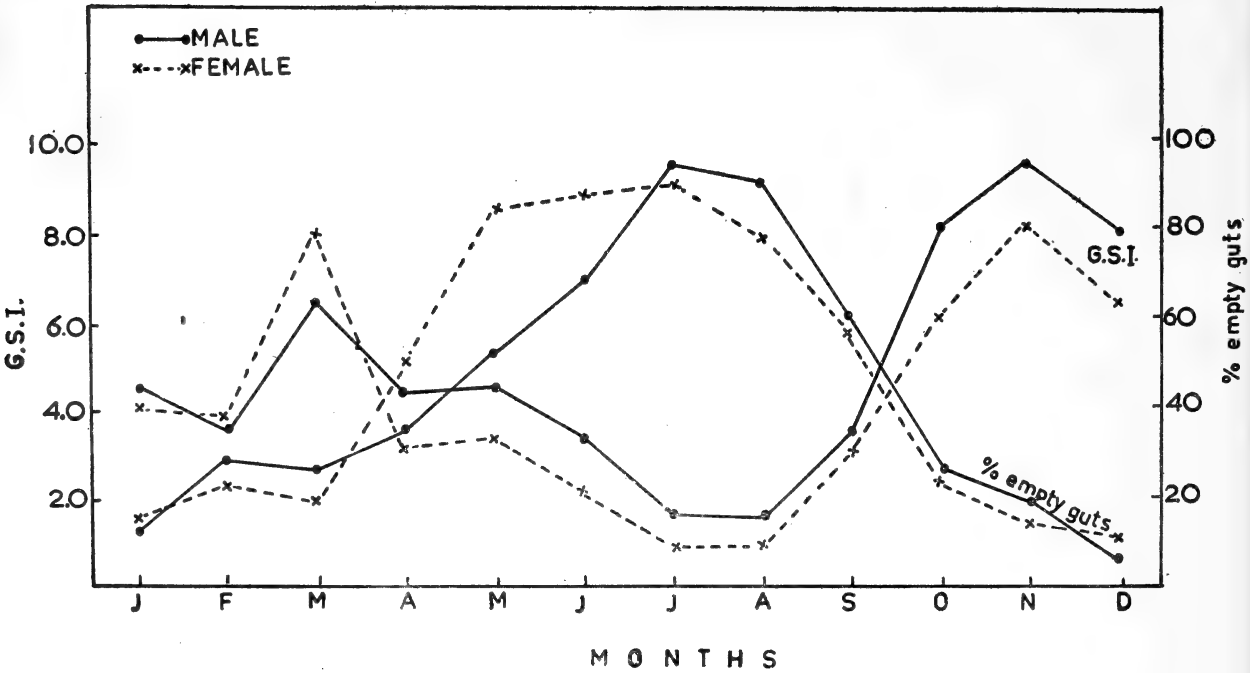

Fig. 2. Seasonal variation in the intensity of feeding of *L. gonius.*

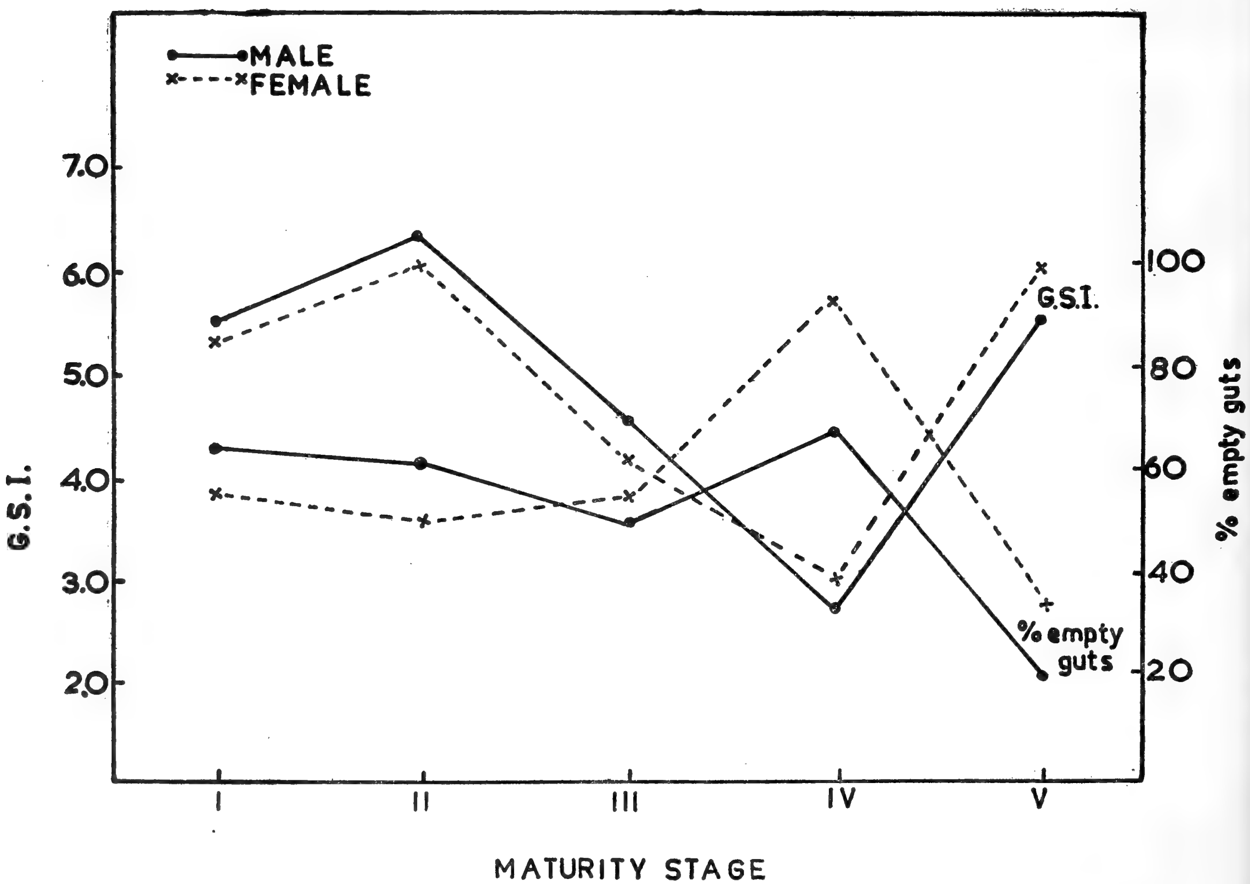

Fig. 3. Intensity of feeding at different maturity stages of *L. gonius.*

Intensity of feeding

The values of gastro-somatic index along with the percentage of empty guts for different months are given in Fig. 2. A pronounced feeding activity was recorded from October to March. The feeding intensity was extremely low during July and August.

In both the sexes the intensity of feeding was high in immature, maturing and spent fishes and low in ripening and ripe fishes. The feeding intensity was found to be better in males than in females throughout the year, especially in the spent fishes (Fig. 3).

The relative precentage of different food items varied from month to month and a particular type of food item tended to be maximum at a particular time, perhaps due to its abundance in the environment at that time. There appears to be a definite preference for particular species or genus of phytoplankton. Generally the small sized phytoplankton and decayed organic matter were preferred.

Seasonal variation in the rate of feeding appears to be affected by temperature and flooding of the river as low food intake was recorded during monsoon months (June, July and August) and high rate of feeding during rest of the months. The feeding intensity was also influenced by the state of maturation of gonads.

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SOME ASPECTS OF THE BIOLOGY OF A TROPICAL EARTH-WORM *PONTOSCOLESE CORETHURUS* (O.F. MULLER)[1]

S. ARUNACHALAM[2]

(*With three text-figures*)

Individuals of *P. corethurus* were found abundantly during rainy seasons of the year, distributed at a depth of 5 cm. These earthworms produced cocoons only during the rainy season. The average number of cocoons produced was 14 ± 2.2 cocoons per month. The cocoons were *c* 3.3 ± 0.4 mm in diameter and 28.3 ± 1.18 mg in weight. The cocoons hatched on the 21 ± 1st day of incubation at room temperature, i.e. 28°C. Temperature accelerated development. At extreme temperatures they failed to develop. Only one worm hatched out from a cocoon. Freshly hatched *P. corethurus* was 1.7 ± 0.18 cm in length; 1.4 ± 0.06 mm in diameter and 13.4 ± 0.87 mg in weight. The average number of segments at birth was 230 ± 10. *P. corethurus* attained an average body weight of 217.5 ± 38.58 mg on the 91st day.

Our knowledge of the biology of even quite common earthworms is very inadequate; and the life cycle of many species of earthworms are still obscure (Edwards & Lofty 1972). With the view that life cycle studies on earthworm may provide some useful information for effective earthworm culture, the present work on some aspects of biology of a glossoscolecid worm of India was undertaken. The distribution of this glossoscolecid worm *Pontoscolese corethurus* in Palni is unique since the authorities of the British museum Natural History state that this species is particularly common on beaches in most of the tropical regions of the world (in litt.).

MATERIAL AND METHOD

Individuals of *Pontoscolese corethurus* (O. F. Muller: Family Glossoscolecidae) were collected from shady areas in irrigated lands during the rainy season, in and around Palni when the soil temperature was about 27 ± 1°C. These were cultured in the laboratory using natural medium. The length, width, and live body weight were measured. In taking live weight suitable corrections were made for the gut content.

20 groups of matured *P. corethurus*, each group consisting of 5 individuals were reared in glass terraria (6″ x 9″ x 12″) in the natural medium. Daily observations were made for about 3 months (November to January) to find out the average number of cocoons produced by single individual per month. Duration between successive ovipositions of a single earthworm was also observed by rearing them singly in a terrarium. Twenty earthworms were thus observed for a period of about one month.

The fresh cocoons were weighed, using a sensitive (0.01 mg) balance and the width of the cocoons was measured using screw gauge. Fresh cocoons were kept with natural medium at different temperatures, i.e. 15, 21,

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28 and 34°C and allowed to develop. The incubation period of these cocoons was noted. After hatching, the initial length, width, number of segments, and live weight were measured.

To measure the growth rate, 10 groups (5 in each) of young ones hatched at 28°C were cultured using natural medium in the laboratory for a period of 90 days. The growth was measured at regular intervals of 15 days, by taking live weight. Suitable corrections were made for the gut contents.

Results and discussion

1. *Distribution*:— *P. corethurus* occurred abundantly in shady places in irrigated fields from October to January at a depth of 5 cm, when the soil temperature was 28°C. At other seasons of the year, these earthworms were hardly found even at a depth of over 25 cm, when the soil temperature had risen to above 32°C. It appears that as the soil temperature rises the earthworms move into deeper parts of the soil. Gerard (1967) has pointed out that *A. chlorotica, A. caliginosa* and *A. rosea* were distributed at a depth of 7.5 cm of soil at suitable climatic conditions and moved into the deeper parts when the soil temperature rose or fell to a greater extent.

2. *Cocoon production*:— Cocoons of *P. corethurus* were collected from the fields along with the earthworms at a depth of 5 cm during rainy season from October to January. The cocoons were not found during other seasons. Similar observations were made by Evans & Guild (1948) and Satchel (1967) who stated that the environment influenced the production of cocoons by any species of earthworm. Such restricted breeding behaviour has also been observed in some other glossoscolecid worms such as the marsh dwelling worm *Criodrilus lacuum* and *Alma* sp. which produced cocoons only during cold seasons (Edwards & Lofty 1972). Bahl (1922) also reported that few species of *Phretima* produced cocoons during rainy months.

P. corethurus reared in the laboratory also produced cocoons only during cold season from October to January. After January they did not produce cocoons, confirming the field

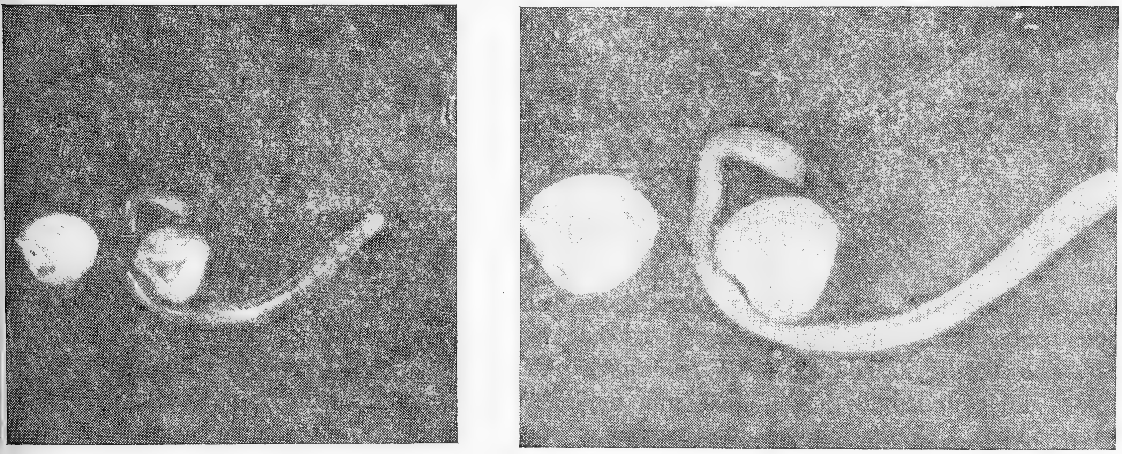

Fig. 1. Photograph of developing cocoons and freshly hatched *Pontoscolese corethurus*.

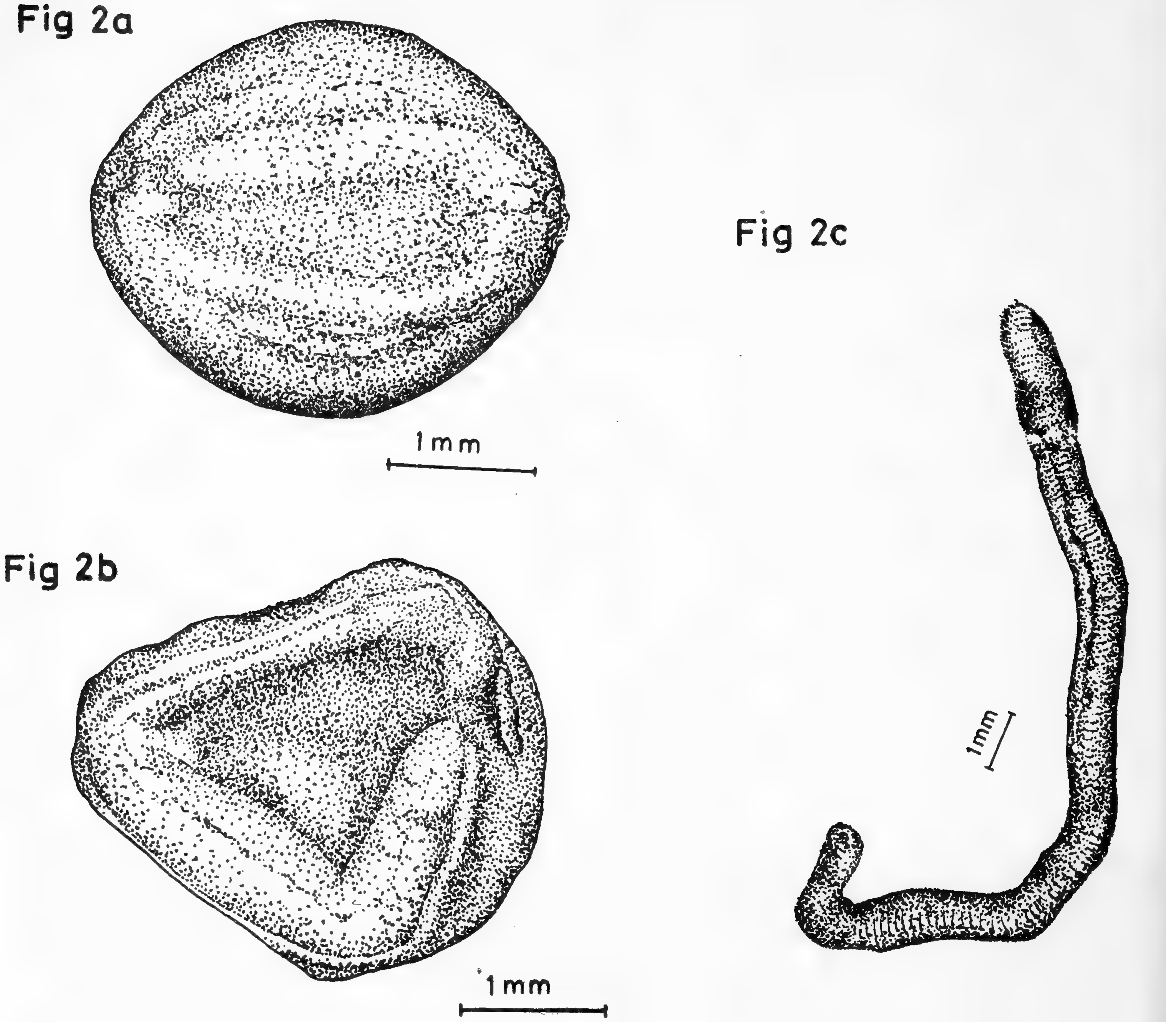

Fig. 2. Camera lucida drawings of developing cocoons (a, b) and freshly hatched juvenile of *Pontoscolese corethurus* (c).

observation that *P. corethurus* produces cocoons only during the rainy season of the year. The mature individuals of *P. corethurus* (7.4 ± 1.04 cm length; 3.2 ± 0.28 mm diameter; 533.5 ± 39.09 mg weight) reared as groups in different terraria produced as many as 14 ± 2.2 cocoons per month per individual. The duration between two successive ovipositions of *P. corethurus* was 3 to 13 days.

Fresh cocoons of *P. corethurus* were more or less spherical in shape, opaque and milk white in colour. Cocoons were about 3.3 ± 0.4 mm in diameter and 28.3 ± 1.18 mg in

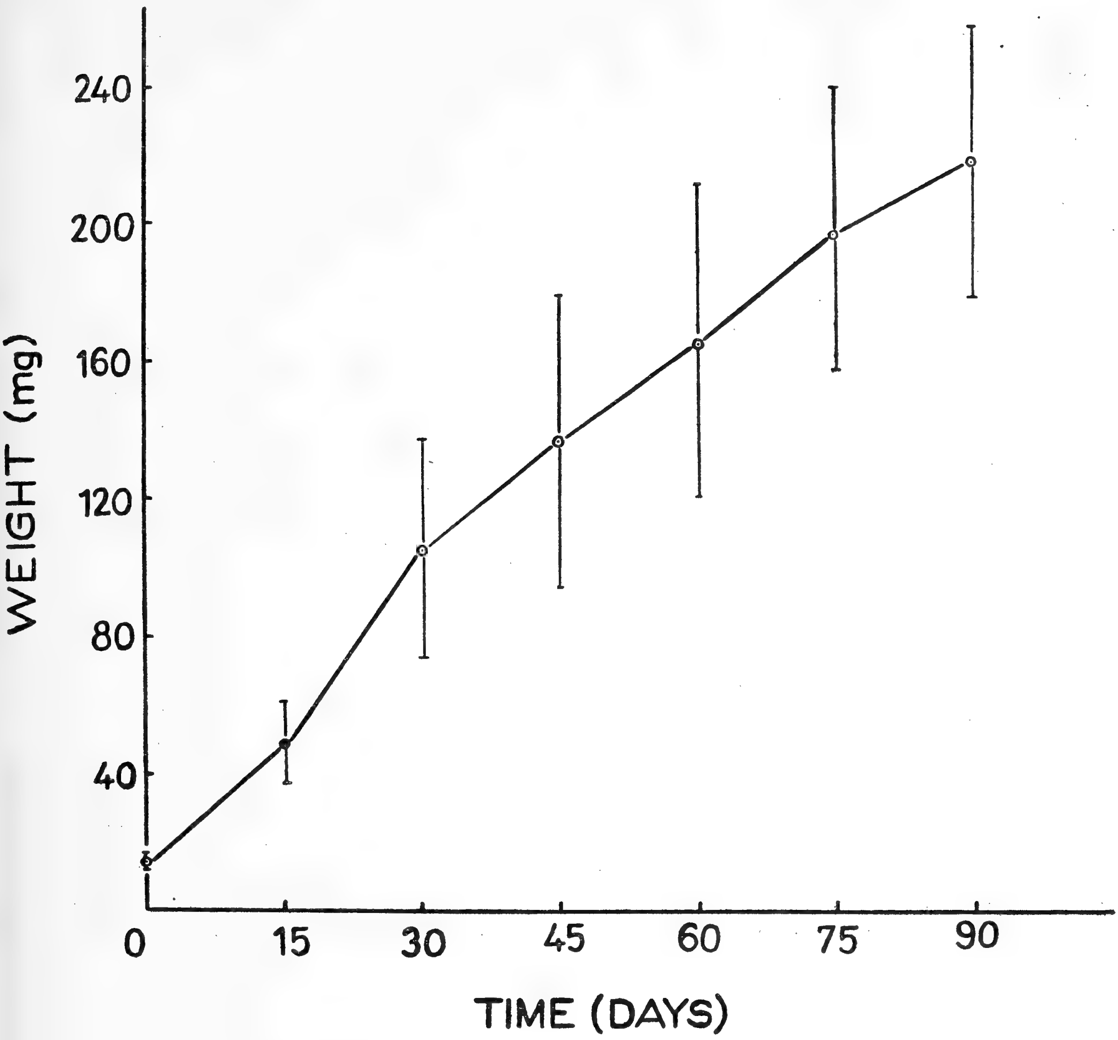

Fig. 3. Growth of the earthworm *Pontoscolese corethurus;* each value represents the average performance of 50 individuals cultured in laboratory.

weight. The shape and size of the cocoons vary in different species of common earthworms (Edwards & Lofty 1972).

3. *Incubation*:—The cocoons were kept at room temperature, i.e. 28°C. As development proceeded, the cocoons became translucent; after one week white streaks appeared in the cocoons; and after two weeks the cocoons became slightly red in colour apparently due to blood circulation (Figs. 1 and 2a and 2b). The cocoons hatched on the 21st ± 1 day of incubation. The incubation period increased from 21 ± 1 day to 26 ± 1 day when the cocoons were kept at 22°C. It

appears that higher temperature accelerates the development. Similar effect of temperature on the development of earthworm's cocoon was observed by Gerard (1967) who stated that *A. chlorotica* hatched after 30 days of incubation at 20°C; after 50 days at 15°C, and 112 days at 10°C. The cocoons of *P. corethurus* did not hatch at 15°C and 34°C. The reason for such failure in hatching is still to be examined. It was observed that only one worm hatched out from each cocoon. This is the general rule in most species of earthworms. Evans & Guild (1948) reported that thirteen out of fourteen species of Lumbricid worms produced only one worm from a cocoon.

4. *Growth*:—Freshly hatched *P. corethurus* was 1.7 ± 0.18 cm in length; 1.4 ± 0.06 mm in diameter and 13.4 ± 0.87 mg in weight. (Fig. 2c). The average number of segments at birth was 230 ± 10. These young ones attained an average body weight of 217.5 ± 38.58 mg on the 91st day (Fig. 3). As seen from the fig. 3 the growth rate is found to be linear. Phillipson (1971) working on the European species, *Lumbricus terrestria* has also observed a growth rate of 175 mg in 3 months duration.

ACKNOWLEDGEMENTS

Thanks are due to Prof. K. Arunachalam, Principal and P. G. Professor of Zoology for offering facilities, Dr. T. J. Pandian for his valuable guidance and encouragement and Dr. E. G. Easton, (British Museum Natural History) for confirming the identification of the earthworm.

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THE SEASONAL OCCURRENCE OF BIRDS ON THE NEW DELHI RIDGE[1]

A. J. GASTON[2]

(With six text-figures)

INTRODUCTION

From July 1971 to June 1974 I was engaged in research on babblers of the genus *Turdoides* in an area of scrub and *Prosopis* woodland adjacent to New Delhi. The area constitutes part of the ridge which runs south from the campus of the University of Delhi, on the west side of the city. Observations were mainly confined to an area about 2 km² immediately west of Willingdon Crescent, stretching as far as New Rajinder Nagar. During the course of field work, which included the trapping of nearly one thousand birds with mist nets, a record was kept of species observed each day and, for less common species, the number seen. The study area was visited for 4-10 hours on most days during 106 weeks out of the period specified above and total observation time amounted to about 3000 hours. From this concentrated series of observations on a single locality it was possible to obtain a good impression of seasonal changes in the occurrence of different species.

A number of authors have contributed to our knowledge of the birds of Delhi and information on their status is summarised in the Check List produced in 1967 by the Delhi Bird Watching Society, referred to throughout this paper as "the Check List". Detailed notes on habitats and breeding seasons are given in Major-General Hutson's excellent book THE BIRDS ABOUT DELHI (1947). Most previous information was assembled from casual or intermittent observations made in a variety of different habitats and this has tended to obscure patterns of seasonal variation within a particular habitat. The present paper intends to illustrate such seasonal patterns for birds found in dry deciduous woodland and scrub around Delhi. Comparisons of status will be made with the notes included in the 1967 Check List and with comments in the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali & Ripley 1969-74), which is referred to throughout as "the Handbook".

During the course of the study a number of observations were made of species which had not previously been recorded in the Delhi area and details of these observations are given, along with notes on species listed in the Check List as "very uncommon" or "accidental", in a systematic list following the data on seasonal fluctuations. This systematic list includes a few observations made inside the Union Territory of Delhi, but away from the area specified above.

Coverage was not uniform throughout the period of the study and there were only five months during which the observer was present throughout in all three years; February, March, April, August and September. A week was missed in October in each year. November and part of December were missed in 1973 and January was covered only in 1972 and for one week in 1974. The second half of May was missed entirely and only one week of observations were made in June. Mist netting

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was carried out mainly in August-November and a few species were recorded only when trapped by this means.

Results

To express the seasonal pattern of records for each species Table 1 shows the proportion of weeks in every month during which each species was recorded in the Ridge study area, in relation to the total number of weeks in that month during which the observer was present. Four categories are used; a dash indicates that the species was not recorded at all in that month, × indicates that it was recorded in less than half the weeks of observation, ×× in half or more of the weeks, and ××× in all of the weeks of observations in that month. Table 1 includes those species which were recorded more than once in the study area, but not in every week of observations. Table 2 lists species recorded only once, with the month of occurrence, and Table 3 lists common species which were recorded in every week. The number of weeks of observations made in each month are shown at the top of Table 1.

For a few species of passage migrants the number of birds seen in each quarter month during the autumn are illustrated in figures 1-5, to show the extent to which passage is concentrated. Some species could be seen migrating during the day over the study area and the numbers of these and their direction were recorded. Numbers of Drongos *Dicrurus adsimilis* recorded on migration in spring are shown in figure 6, which includes only birds seen flying steadily north or northwest.

The peak period for the passage of most Palaearctic migrants through the Delhi area was the first three weeks of September. Blyth's Reed Warbler *Acrocephalus dumetorum*, which was recorded in the study area throughout August-October, moults in this part of North India before continuing its migration (Gaston 1976). For the other warblers there was relatively little variation between years, with the peaks for both Crowned leaf-warblers *Phylloscopus occipitalis* (Figure 2) and Greenish Warblers *Phylloscopus trochiloides* (Figure 3), the most numerous species, falling in the first two weeks of September in all three seasons.

Peak passage of Ashy Drongos *Dicrurus leucophaeus* (Figure 4), a summer visitor to the foothills of the NW Himalayas, occurred in the last quarter of September in all three seasons. The peak passage of Rosy Pastors *Sturnus roseus* (Figure 5) was probably missed in 1971, when observations did not begin until the last days of July, but in 1972 there was a clear peak in the first quarter of August. Spring passage of Black Drongos *Dicrurus adsimilis* was observed throughout March and April, with a peak in 1972 and 1973 in the second half of March. Resident birds appeared to arrive in the study area during late February and early March.

The seasonal patterns illustrated by table 1 are summarised in table 4, which shows the proportions of the 167 species recorded in the study area which fell into each status class. It is interesting to compare these figures with those given in the Check List for the entire avifauna of Delhi. When all 322 species are considered 53% are listed as resident, 34% as winter visitors, 3% as summer visitors and 6% as passage migrants.

Differences between the study area and the entire Delhi area may partly reflect deficiencies in the year-round coverage of the larger area, which no doubt resulted in some late migrants being classified in the Check List as winter visitors (*Acrocephalus agricola*,

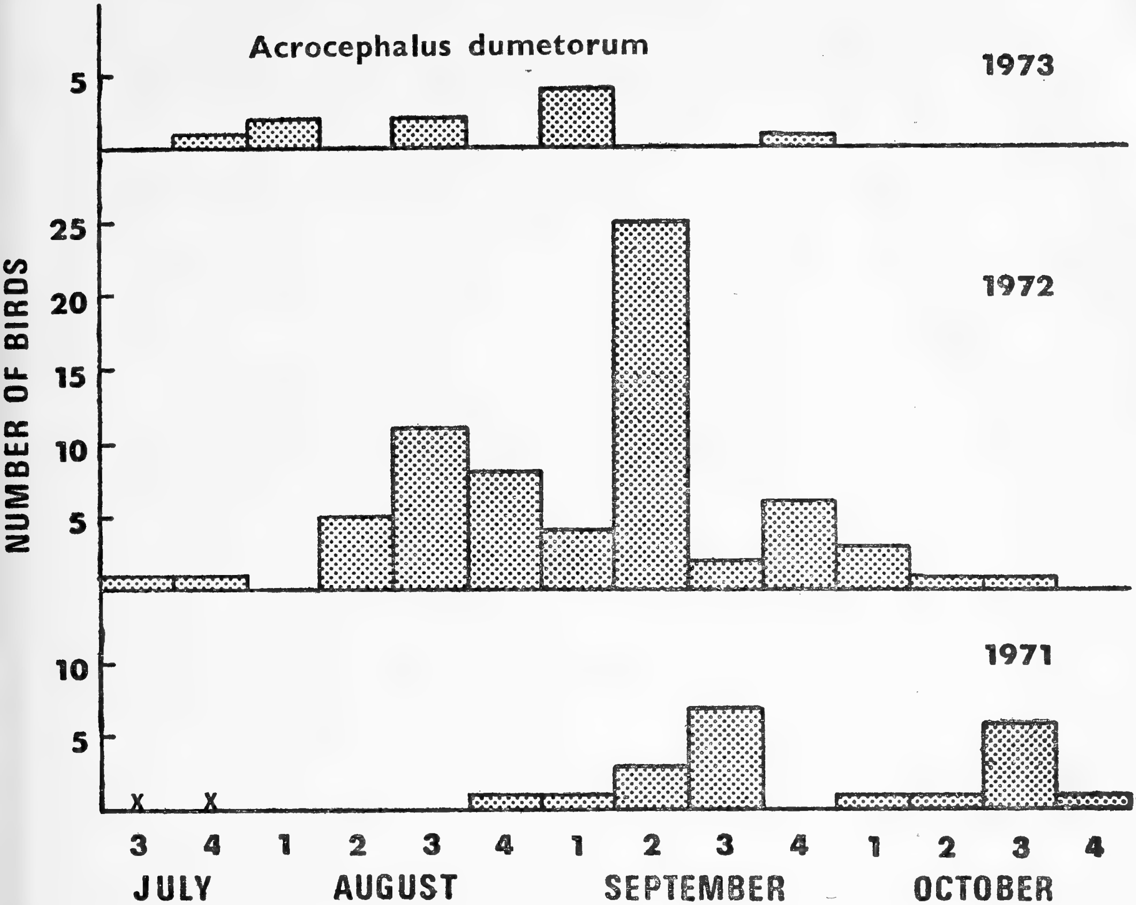

Fig. 1. Number of records of Blyth's Reed Warbler *Acrocephalus dumetorum* in the Ridge study area per $\frac{1}{4}$ month. $\times$ = no observations.

Phylloscopus affinis) and some winter visitors being considered passage migrants (*Phylloscopus griseolus*). The bulk of the difference, however, probably reflects real differences between the patterns of seasonal occurrence of birds in the dry woodland and scrub of the ridge and those in other types of habitat in the Delhi area; particularly the moist riverine tract beside the River Yamuna.

Many species that occur only during the summer in the study area can be seen throughout the year in the riverine belt. These included *Butastur teesa, Vanellus indicus, Halcyon smyrnensis, Coracias benghalensis, Megalaima haemacephala, Dicrurus adsimilis, Rhiphidura aureola, Terpsiphone paradisi, Petronia xanthocollis, Ploceus philippinus.* The same is true of some species recorded only on passage in the study area; *Acrocephalus stentoreus,* and *Saxicola caprata.* A number of other species recorded in the study area only on passage occur throughout the winter in the riverine belt; *Tringa* spp., *Hirundo rustica, Saxicola torquata, Anthus hodgsoni, A. trivialis, Motacilla flava, M. alba.* A few such as *Elanus caeruleus* and *Lanius excubitor* are

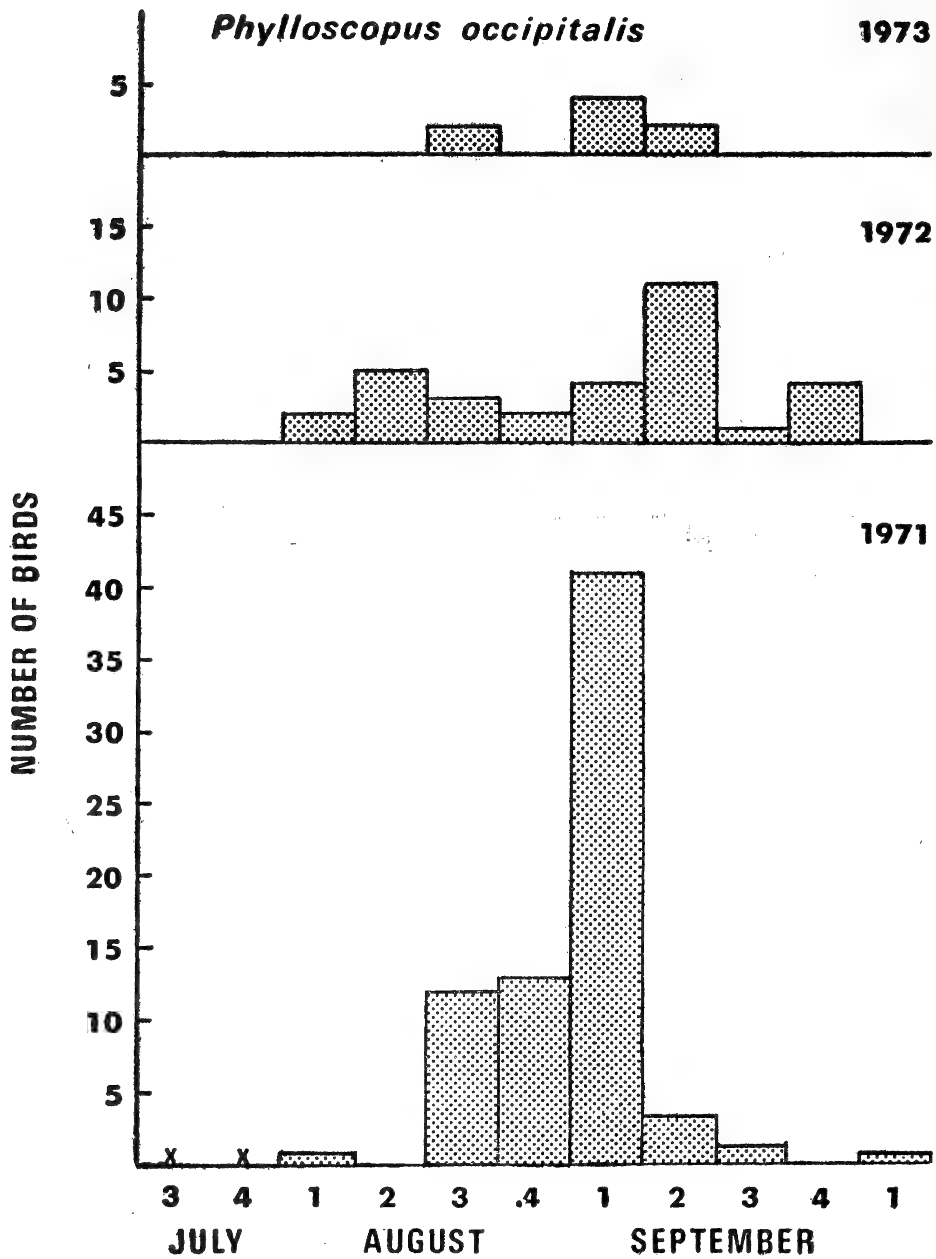

Fig. 2. Numbers of records of Crowned Leaf-warblers *Phylloscopus occipitalis* in the Ridge study area per $\frac{1}{4}$ month.

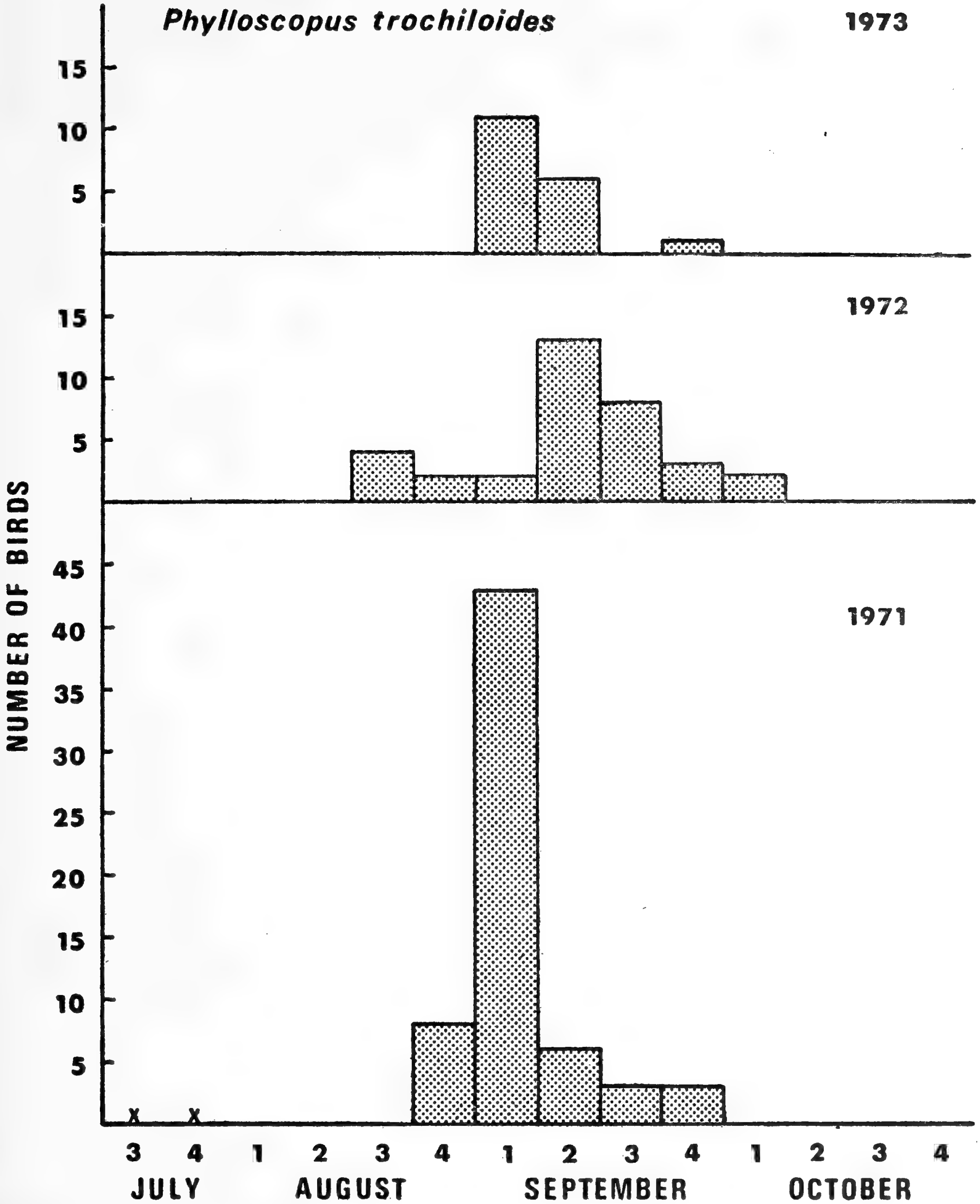

Fig. 3. Numbers of records of Greenish Warblers *Phylloscopus trochiloides* in the Ridge study area per $\frac{1}{4}$ month.

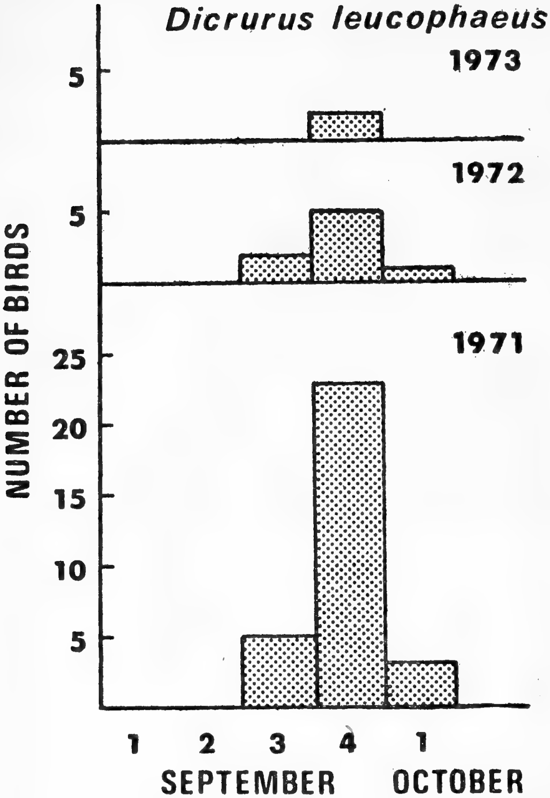

Fig. 4. Numbers of records of Ashy Drongos *Dicrurus leucophaeus* in the Ridge study area per $\frac{1}{4}$ month.

resident in the riverine belt, but occur in the study area only in winter. The relatively larger number of species which leave the study area during the winter, though resident in moist areas nearby, probably reflects a deterioration in the habitat during the winter as vegetation dries up following the end of the rains in September.

For some species the pattern of seasonal movements in North India may be quite complex. The Green Bee-eater *Merops orientalis* for instance breeds around Delhi during the summer in both dry and moist habitats. Some birds winter, although many more do so in moist than in dry areas and in spring and autumn large numbers occur on passage. Whether the wintering birds are part of the breeding population or whether different birds move in during the winter, and whether birds leaving dry habitats migrate south or merely shift to moist areas nearby could only be determined by a concentrated ringing programme. Similar questions could be posed concerning *Lanius* spp., *Dicrurus adsimilis* or *Petronia xanthocollis*.

Some species appear quite erratic in their occurrence around Delhi. The nightjars *Caprimulgus* spp. form a good example. *C. indicus* was present in the study area during only one

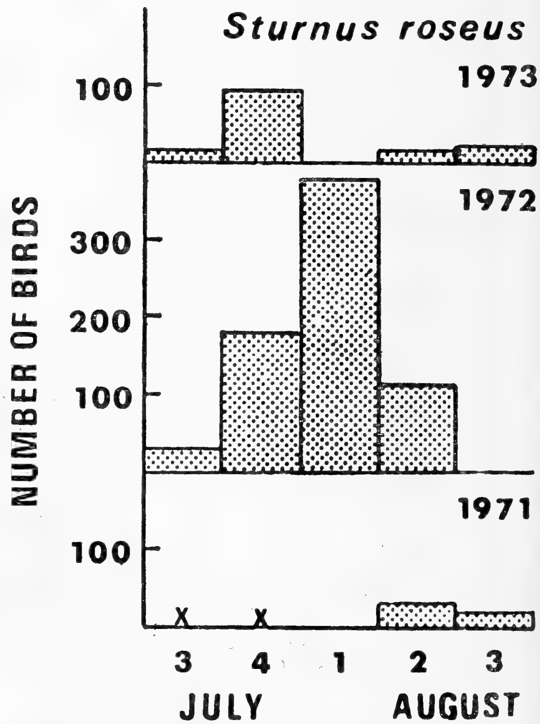

Fig. 5. Numbers of records of Rosy Pastors *Sturnus roseus* in the Ridge study area per $\frac{1}{4}$ month period.

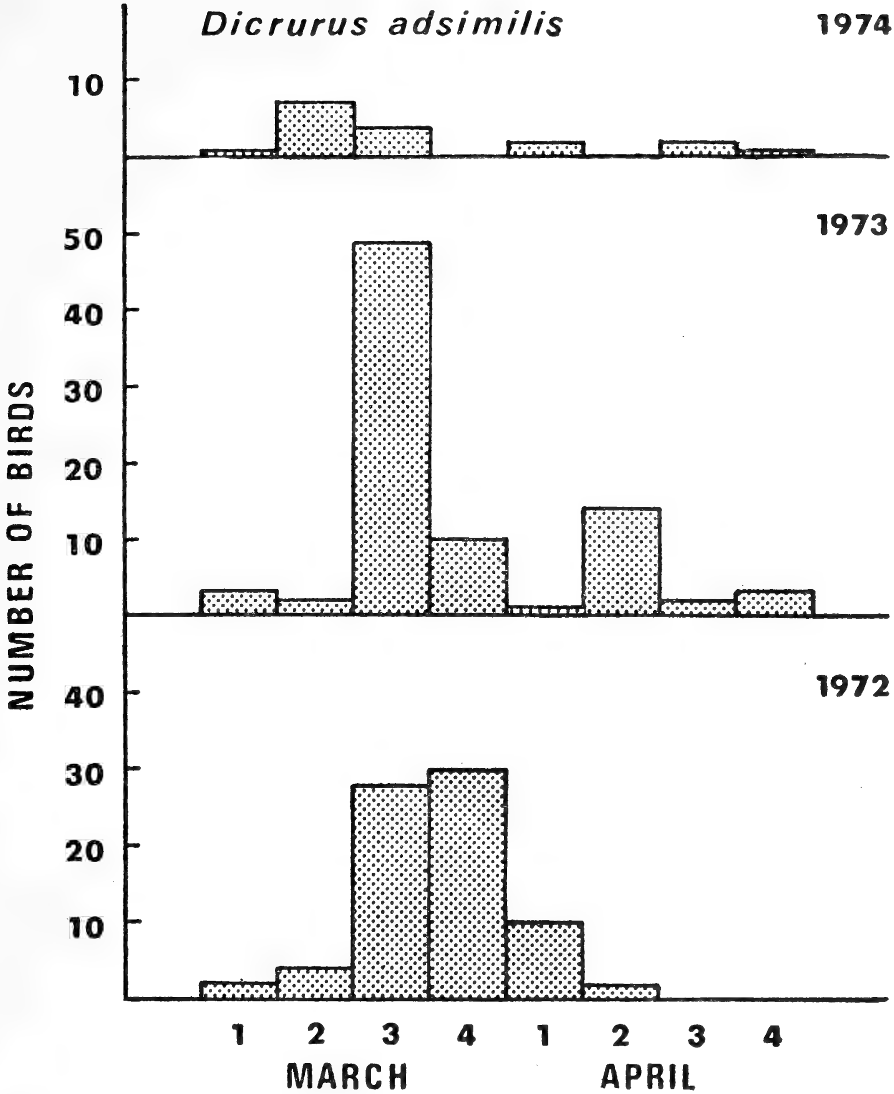

Fig. 6. Numbers of records of Black Drongos *Dicrurus adsimilis* migrating N or NW over the Ridge study area in spring, per $\frac{1}{4}$ month.

period of four weeks in the autumn of 1973, when several birds were heard singing. *C. macrurus* was heard singing several times in March 1973, while several *C. affinis* were singing in June 1974. All three species were otherwise rare and it would be interesting to know what factors govern the arrival of the different species.

Winter visitors such as *Jynx torquilla, Muscicapa parva* and *Sylvia hortensis* remain around Delhi in much larger numbers in some winters than in others. None were seen during the exceptionally severe weather of January-February 1974. *Sylvia curruca* and *Phoenicurus ochruros* appear to fluctuate in numbers less. The fact that several birds of each species were retrapped within a few yards of sites where they had been netted in a previous winter suggests that they return to the same territories in successive seasons. During hard weather in the Punjab Hills, Black Bulbuls *Hypsipetes madagascariensis* made an appearance in the study area, well beyond their normal range, and Black-throated Thrushes *Turdus ruficollis* occurred in large numbers (Gaston 1973).

Changes in the status of birds around Delhi are difficult to assess because of differences in the way that observations have been collected over the years. One species at least, the White-bellied Minivet *Pericrocotus erythropygius,* appears to have declined in the Delhi area. Basil-Edwards (1926) records it as not uncommon in parties of up to six, but Frome (1947) considered it was not at all common and the species was not recorded in the present study. The Jungle Wren-Warbler *Prinia sylvatica,* noted by Hutson as a scarce resident and by the Checklist as uncommon, was also not recorded although the dry habitat of the study area may not be suitable for the species. The Whitecapped Bunting *Emberiza stewarti,* a common winter visitor to the study area, was recorded in the Check List as very uncommon and this species may have become more numerous around Delhi.

While 167 species were recorded in the study area during the course of the study the maximum number likely to be seen in a day was about 60. Among those seen regularly, however, were several species not easily recorded elsewhere around Delhi; Sirkeer *Taccocua leschenaultii,* Indian Nightjar *Caprimulgus asiaticus,* Redwinged Bush Lark *Mirafra erythroptera* and the Leaf Warblers *Phylloscopus griseolus, P. occipitalis* and *P. subviridis.* To have such an area of virtually undisturbed semi-natural woodland so close to a major city is extremely fortunate for people in Delhi interested in birds or other aspects of natural history. It would be useful if part at least of the area could be set aside specifically as a nature reserve because it has great potential as an educational asset. There is some danger at present that the vegetation could degenerate under the twin pressures of grazing and wood-cutting and an excellent facility might be lost.

Systematic list of species included in the 1967 Check List of Delhi Birds as "very uncommon", "accidental", or omitted entirely, and hence previously unrecorded in the Union Territory. The status as recorded in the Check List is given in brackets after the name of the species (Acc. = Accidental, V. Unc. = Very Uncommon, NR = Not recorded).

Accipiter nisus (V. Unc.)

Probably largely a spring passage migrant. Apart from singles on Dec. 19, 1971 and Feb. 13, 1972 all other records (6) were in March and April.

Buteo hemilasius (Acc.)

One seen soaring over the study area on March 9, 1973.

Falco subbuteo/severus (Acc.)

Small, long-winged falcons belonging to one or other of these two species were seen over the study area on Oct. 7, 1971, Nov. 1, 1972 and July 26, 1973.

Vanellus cinereus (NR)

One seen beside a small pool on the East side of the river Yamuna, opposite Okhla on Dec. 5, 1972. This bird was also seen by R. Smith and three other experienced ornithologists. According to the HANDBOOK it winters in NE India and is only a rare straggler in the West.

Streptopelia chinensis (V. Unc.)

Recorded in the study area on April 15, 1972 (2), May 3, 1972, April 3, 1973 and Jan. 29, 1974.

Otus scops (Acc.)

One trapped in a mist net in the study area on Feb. 8, 1973.

Caprimulgus indicus (Acc.)

Heard calling regularly in the evenings between Aug. 20-Sept. 17, 1973 in the study area.

Caprimulgus macrurus (V. Unc.)

One trapped on Dec. 19, 1972 in the study area and identified by Shahid Ali. The 'chaunk-chaunk' call was heard several times in March 1973.

C. affinis (V. Unc.)

Single birds were heard singing in the study area on Sept. 10, 1973 and March 3 and June 5, 1974. Both Frome (1947) and Donahue (1967) record this species in the Delhi area during July-September, but Benthall (1949) recorded large numbers in May. The species may be a regular passage migrant.

Anthracoceros malabaricus (Acc.)

Single birds seen in the study area on Feb. 12 and March 28, 1973.

Dicrurus leucophaeus (V. Unc.)

A regular passage migrant in small numbers in autumn (see fig. 1), but only two spring records. One bird trapped in a mist net was sent to the BNHS for confirmation of identification. Most birds appeared to be in immature plumage.

Coracina novaeholandiae (Acc.)

One seen near Delhi University on Aug. 9, 1971 and one in the study area on March 28, 1973.

Pericrocotus ethologus (NR)

A regular winter visitor to the study area in small numbers (see table 1), usually in parties of up to six, comprising mainly females and immature males. The Check List included the very similar *P. brevirostris,* but according to the HANDBOOK this species is unlikely to occur around Delhi and previous records of *brevirostris* probably refer to *ethologus.*

Hypsipetes madagascariensis (NR)

Two were recorded in the study area on Feb. 12, Feb. 24 and March 7, 1972, and three on March 9. For further details see Gaston (1973).

Muscicapa striata (NR)

Single birds were recorded in the study area on Sept. 9 and 15, 1972. According to the HANDBOOK this species is a regular passage migrant to the West of Delhi.

M. superciliaris (Acc.)

Single birds were recorded in the study area on March 13, 15, 16 and 29, 1973. All these sightings may have involved the same bird. The species is not included in the 1967 Check List but it is listed in a cyclostyled addendum.

M. rubeculoides (NR)

One female or immature trapped on Oct. 22, 1971 and sent to BNHS. Identification per A.S. Cheeke.

Prinia flaviventris (NR)

Two birds were seen carrying nest material on the edge of a *Typha* marsh near milepost one on the canal road south of Okhla on March 26, 1973. On May 12, 1973 at least

four birds were present in the same area and on March 29, 1974 two were seen. The HANDBOOK shows the distribution of the western race, *sindiana,* extending as far east as Ambala, Punjab and the Delhi birds must almost certainly be of that race.

Sylvia communis (NR)

Single birds were trapped in the study area on Sept. 14, 1971 and Sept. 7, 1972. A regular passage migrant to the west of Delhi (HANDBOOK).

Sylvia hortensis (V. Unc.)

Regular passage migrant and winter visitor to the study area in small numbers, usually seen in open woodland.

Phylloscopus tytleri (NR)

One observed at close range feeding in the lower branches of *Prosopis* woodland in the study area on Aug. 23, 1973. Due to the difficulty of identifying this species in the field it can only be considered 'probable'.

P. affinis (V. Unc.)

Single birds seen in the study area on Oct. 21 and 23, 1971 and Oct. 8, 1972.

P. pulcher (NR)

Single birds seen feeding in dense woodland canopy in the study area on Sept. 23, 1971 and Oct. 25, 1972.

P. magnirostris (NR)

Single birds seen feeding in the woodland canopy in the study area on Sept. 1, 1971 and Sept. 25, 1972. The first bird was trapped and examined in the hand.

P. occipitalis (V. Unc.)

A regular passage migrant during July-October in the study area, with up to 36 being counted in one week in September 1971. For details of passage see fig. 1. In spring single birds were seen on March 30 and April 16, 1972.

Erythropygia galactotes (NR)

One seen on Aug. 3 and 21, 1972 in the study area. A regular passage migrant further west (HANDBOOK).

Oenathe isabellina (Acc.)

Recorded on several occasions in winter on ploughed land around Delhi.

Monticola cinclorhynchus (V. Unc.)

One female seen in dense woodland in the study area on April 17, 1974.

Zoothera citrina (V. Unc.)

One bird seen in dense woodland in the study area on Oct. 16 and 28, Nov. 10 and Dec. 1, 1971.

Turdus unicolor (V. Unc.)

One in woodland in the study area on Nov. 24, 1971.

Tichodroma muraria (V. Unc.)

One creeping on the walls of Humayun's tomb, Oct. 18, 1971.

Dicaeum agile/erythrorhynchus (V. Unc.)

Flowerpeckers of one of these two species were seen in *Prosopis* woodland in the study area on five occasions.

Lonchura malacca (Acc.)

Six were seen in a mixed flock with Bayas *Ploceus philippinus* and Spotted Munias *Lonchura punctulata* among scrub in the study area on July 24, 1972. Many of these birds are sold in the bird markets in Old Delhi and these could have been escapes.

Emberiza stewarti (V. Unc.)

A numerous winter visitor to the study area between October and May. Flocks of up to 20 were often present in scrub and open woodland. The status accorded to the species in the check list is puzzling and it may have become more abundant recently.

E. buchanani (V. Unc.)

A not uncommon spring passage migrant, up to six being seen in rocky, scrub-covered parts of the study area. One autumn record on Oct. 21, 1971.

TABLE 1

SEASONAL OCCURRENCE OF SPECIES ON THE NEW DELHI RIDGE

Months	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total	Status
Weeks of observations	5	12	13	12	4	1	5	12	14	9	8	11	106	code
Ardeola grayii	x	–	x	–	–	xxx	–	x	–	x	–	x	9	O
Bubulcus ibis	–	–	–	–	–	xxx	xx	xxx	xxx	x	–	–	30	V
Elanus caeruleus	xxx	xx	xx	x	–	–	x	x	x	x	xx	xx	52	W
Pernis ptilorhynchus	–	–	x	x	–	–	x	–	–	–	x	x	9	O
Accipiter nisus	–	x	x	x	–	–	–	–	–	–	–	x	9	Ps
Buteo rufinus	–	–	x	x	–	–	–	–	–	–	–	–	3	Ps
Butastur teesa	–	–	xx	xx	x	–	xxx	xxx	xxx	xx	–	x	55	S
Aquila rapax	x	x	x	x	–	–	–	–	x	–	–	–	11	W
A. clanga	–	–	x	–	–	–	–	–	–	–	–	–	2	O
Torgos calvus	–	–	x	–	–	–	x	–	–	x	–	x	5	O
Circus cyaneus	–	x	x	–	–	–	–	–	–	–	–	–	2	W
C. pyrargus	–	–	–	–	–	–	–	–	–	–	–	x	2	W
C. aeruginosus	–	–	x	x	–	–	–	–	–	–	–	–	2	Ps
Spilornis cheela	–	x	xx	xx	x	–	xx	x	x	xx	xx	x	47	R
Falco peregrinus	–	–	–	–	–	–	x	–	x	–	–	–	2	O
F. subbuteo/severus	–	–	–	–	–	–	x	–	–	x	x	–	4	Pa
F. tinnunculus	x	x	x	x	x	–	–	–	–	–	x	–	12	W
Vanellus indicus	–	x	xxx	xx	xxx	xxx	xxx	xx	xx	xx	x	x	71	S
Tringa ochropus	–	x	xx	x	–	–	–	x	xx	xx	xx	x	35	P
T. glareola	–	–	x	–	–	–	–	–	x	–	–	–	5	P
Burhinus oedicnemus	x	x	x	x	xx	xxx	xx	x	xx	xx	x	x	48	R
Treron phoenicoptera	–	–	x	x	x	xxx	–	–	–	–	–	–	7	S
Streptopelia orientalis	–	–	–	x	–	–	–	–	–	x	x	–	7	P
S. tranquebarica	–	–	x	xx	xxx	xxx	xx	x	x	–	–	–	24	S
S. chinensis	x	–	–	x	x	–	–	–	–	–	x	–	5	O
Psittacula eupatoria	xx	x	x	–	x	xxx	–	–	x	x	xx	xx	23	R
P. cyanocephala	xxx	xx	xx	xx	xx	xxx	xx	xx	xx	x	xx	xx	75	R
Clamator jacobinus	–	–	–	–	–	xxx	xxx	xxx	xx	–	–	–	30	V
Cuculus varius	–	–	x	x	–	xxx	xx	xx	xx	xx	x	–	38	V
C. canorus	–	–	–	x	–	–	–	x	x	–	–	–	6	P
Eudynamys scolopacea	–	x	x	xx	xx	xxx	xx	xx	xx	xx	x	–	53	S
Taccocua leschenaultii	x	x	xx	xx	xx	xxx	xx	xx	xx	xxx	xxx	xx	66	R
Centropus sinensis	xx	xx	xxx	xxx	xxx	xxx	xx	xx	xxx	xx	x	xx	83	R
Otus bakkamoena	–	x	–	x	–	–	–	–	–	–	–	–	2	O
Bubo coromandus	–	x	–	–	–	–	–	–	–	–	x	–	2	O
Athene brama	x	x	x	–	–	–	–	–	x	–	–	x	10	R?
Caprimulgus indicus	–	–	–	–	–	–	–	x	x	–	–	–	5	V
C. asiaticus	–	–	–	–	–	–	xx	x	xx	xx	–	x	17	V
C. affinis	–	–	x	–	–	xxx	–	–	x	–	–	–	3	O
Apus affinis	–	x	xx	xx	xx	xxx	xxx	xx	xx	x	x	x	46	S
Alcedo atthis	–	–	–	–	–	–	xx	–	x	x	–	–	6	V
Halcyon smyrnensis	–	x	xx	xx	xxx	xxx	xxx	xx	xx	x	xx	x	50	S
Merops superciliosus/persicus	–	–	–	x	–	xxx	–	–	xx	xx	–	–	21	P
M. orientalis	xx	x	xxx	xx	xxx	xxx	xxx	xx	xxx	xx	xx	xx	86	R/P
Coracias benghalensis	–	–	x	x	x	–	x	x	xx	x	–	–	24	S/P
Upupa epops	–	xx	xx	xx	xx	xxx	xxx	xxx	xxx	xx	xx	xx	67	R/P
Tockus birostris	–	–	–	–	–	–	x	x	x	–	–	–	6	V
Anthracoceros malabaricus	–	x	x	–	–	–	–	–	–	–	–	–	2	O
Megalaima zeylanica	x	–	x	xx	xx	–	xx	xx	x	x	x	–	34	S
M. haemacephala	–	–	x	x	xx	xxx	xx	x	x	–	x	x	24	S
Jynx torquilla	xx	x	x	xx	x	–	–	–	x	x	x	x	28	W
Mirafra erythroptera	x	x	xx	xxx	xxx	xxx	xx	xx	xx	xx	xx	x	61	R/S
Hirundo rustica	–	–	x	x	–	–	xxx	xx	xx	x	x	x	38	P
Lanius excubitor	x	–	x	–	–	–	–	–	–	x	xx	xx	16	W

Months	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total	Status
Weeks of observations	5	12	13	12	4	1	5	12	14	9	8	11	106	code
L. vittatus	xx	x	xxx	xxx	xxx	xxx	xxx	xx	xxx	xx	xx	xx	86	R/S
L. collurio	–	x	x	–	–	–	–	–	x	–	x	x	6	W
Oriolus oriolus	–	–	–	x	xx	–	x	x	x	–	–	–	13	S
Dicrurus adsimilis	–	x	xx	xx	xx	xxx	xxx	xxx	xxx	xx	–	x	62	S
D. leucophaeus	–	–	x	x	–	–	–	–	x	x	x	–	13	P
Sturnus pagodarum	x	x	xx	xxx	xxx	xxx	xxx	xxx	xx	xx	x	x	71	R/S
S. roseus	–	–	x	x	x	–	xx	xx	x	–	–	–	22	P
S. vulgaris	–	x	x	x	–	–	–	–	x	x	x	x	16	W/P
S. contra	–	x	x	x	x	xxx	x	x	x	x	xx	x	19	R
Corvus macrorhynchos	–	x	–	x	–	–	x	x	x	x	x	x	13	O
Pericrocotus ethologus	xx	x	x	–	–	–	–	–	–	–	x	x	22	W
Hypsipetes madagascariensis	–	x	x	–	–	–	–	–	–	–	–	–	3	W
Muscicapa striata	–	–	–	–	–	–	–	–	x	–	–	–	2	P
M. parva	xx	x	xx	xx	–	–	–	–	x	xx	xx	x	39	W/P
M. superciliaris	–	–	x	–	–	–	–	–	–	–	–	–	2	Ps
M. thalassina	–	–	x	–	–	–	–	–	–	–	x	–	5	P
Culicicapa ceylonensis	–	–	x	–	–	–	–	–	–	x	–	–	4	P
Rhipidura aureola	–	–	xx	–	–	–	–	–	–	x	–	–	8	P
Terpsiphone paradisi	–	–	–	x	x	–	–	x	x	x	–	–	15	P
Prinia subflava	x	x	x	x	–	–	–	x	x	xx	xx	x	34	R
Acrocephalus stentoreus	–	–	–	x	–	–	–	–	x	–	–	–	2	P
Acrocephalus dumetorum	–	–	–	xx	xx	–	x	xx	xxx	xx	–	–	44	P
A. agricola	–	–	–	x	–	–	–	–	–	x	–	–	2	P
Hippolais caligata	–	–	x	xx	x	–	–	x	–	xx	–	–	17	P
Sylvia hortensis	x	x	x	–	–	–	–	x	x	x	xx	x	26	W/P
S. communis	–	–	–	–	–	–	–	–	x	–		–	2	Pa
S. curruca	xx	xxx	xxx	xxx	xxx	–	–	–	xx	xxx	xx	xxx	85	W/P
Phylloscopus collybita	xx	xx	xx	xx	x	–	–	x	–	xx	xx	xx	53	W/P
P. neglectus	–	–	x	–	–	–	–	–	–	x	x	–	4	P
P. affinis	–	–	–	–	–	–	–	–	–	x	–	–	2	Pa
P. griseolus	xx	x	xx	xx	–	–	–	–	xx	xx	x	x	55	W/P
P. pulcher	–	–	–	–	–	–	–	–	x	x	–	–	2	Pa
P. inornatus	xx	xx	xx	x	–	–	–	–	x	xx	xx	xxx	48	W/P
P. subviridis	xxx	xx	xx	–	–	–	–	–	–	–	–	xx	30	W
P. magnirostris	–	–	–	–	–	–	–	–	x	–	–	–	2	Pa
P. trochiloides	–	–	x	x	–	–	–	x	xx	x	–	–	25	P
P. t. nitidus	–	–	x	x	–	–	–	–	x	–	–	–	6	P
P. occipitalis	–	–	–	x	–	–	x	xx	xxx	x	–	–	25	Pa
Erythropygia galactotes	–	x	–	–	–	–	x	x	–	–	–	–	2	Pa
Erithacus svecicus	–	x	x	x	–	–	–	–	–	x	x	x	8	W/P
Copsychus saularis	–	x	x	xx	–	–	x	x	xx	xx	x	x	31	R?
Phoenicurus ochruros	xx	xx	xxx	xxx	xxx	–	–	–	xx	xxx	xx	xxx	81	W
Saxicola torquata	–	x	x	x	–	–	–	–	x	x	–	–	11	P
S. caprata	–	x	x	–	–	–	x	–	x	–	–	–	9	P
Zoothera citrina	–	–	–	–	–	–	–	–	–	x	x	x	4	W
Turdus ruficollis	xx	xx	xx	x	–	–	–	–	–	–	x	x	29	W
Sitta castanea	–	–	–	–	–	–	–	–	x	–	–	x	3	O
Anthus hodgsoni	–	x	x	x	–	–	–	–	x	x	x	–	8	P
A. trivialis	–	–	x	x	–	–	–	–	x	x	–	–	6	P
A. similis	x	x	x	–	–	–	–	–	x	x	x	x	9	W/P
Motacilla flava	–	–	–	–	–	–	–	–	x	x	–	–	6	Pa
M. caspica	xx	xx	x	x	–	–	–	x	xx	xxx	xx	xx	54	W/P
M. alba	–	–	x	–	–	–	x	–	x	x	x	–	5	P
Dicaeum agile/ erythrorhynchos	–	–	x	–	–	–	–	–	–	–	–	x	5	W
Zosterops palpebrosa	–	x	xx	x	x	–	xx	xx	xx	xxx	x	x	53	S
Passer domesticus	–	x	xx	xx	xx	xxx	xxx	xx	x	x	x	x	44	S
Petronia xanthocollis	–	–	xxx	xxx	xxx	xxx	xxx	xxx	xxx	x	–	–	62	S

Months	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total	Status
Weeks of observations	5	12	13	12	4	1	5	12	14	9	8	11	106	code
Ploceus philippinus	x	–	x	x	–	–	xx	x	x	–	–	–	12	S
Lonchura punctulata	–	–	–	x	–	–	x	x	–	–	–	–	3	O
Carpodacus erythrinus	xxx	x	x	x	–	–	–	–	–	–	x	xx	19	W
Emberiza stewarti	xx	xx	xx	xx	x	–	–	–	–	x	xx	xx	49	W/P
E. buchanani	–	x	x	x	–	–	–	–	–	x	–	–	6	P

Species recorded in every week or in only one week are excluded. xxx; recorded in every week in which observations were made, xx; recorded in half or more of the weeks, x; recorded in less than half of the weeks, –; not recorded in that month. For status code see table 4.

TABLE 2

SPECIES RECORDED IN THE STUDY AREA DURING ONLY ONE WEEK, WITH THE MONTH OF OCCURRENCE

Buteo hemilasius (March) *Aquila heliaca* (April) *Falco biarmicus* (February)
Falco chicquera (September) *Gallinula chloropus* (April)
Otus scops (February) *Caprimulgus macrurus* (December) *Ceryle rudis* (May)
Hirundo flavicola (December) *Acridotheres ginginianus* (November)
Coracina novaehollandiae (March) *Aegithina nigrolutea* (June)
Muscicapa rubeculoides (September) *Phylloscopus tytleri* (August)
Monticolla cinclorhynchus (April) *Turdus unicolor* (November)
Motacilla citreola (November) *Lonchura malacca* (July) *Melophus lathami* (April)

TABLE 3

SPECIES RECORDED IN THE STUDY AREA DURING EVERY WEEK OF THE STUDY

Milvus migrans	*Lanius schach*	*Turdoides striatus*
Accipiter badius	*Acridotheres tristis*	*Prinia hodgsonii*
Gyps bengalensis	*Dendrocitta vagabunda*	*P. buchanani*
Neophron percnopterus	*Corvus splendens*	*P. socialis*
Francolinus pondicerianus	*Tephrodornis pondicerianus*	*Orthotomus sutorius*
Pavo cristatus	*Pericrocotus cinnamomeus*	*Saxicoloides fulicata*
Columba livia	*Pycnonotus jocosus*	*Nectarinia asiatica*
Streptopelia decaocto	*P. leucogenys*	*Lonchura malabarica*
S. senegalensis	*P. cafer*	
Psittacula krameri	*Chrysomma sinensis*	
Dinopium benghalense	*Turdoides caudatus*	
Dendrocopos mahrattensis	*T. malcolmi*	

TABLE 4

SUMMARY OF SEASONAL OCCURRENCE OF SPECIES ON THE RIDGE STUDY AREA

Status	Code in table 1	Number of spp.		Percentage
Resident	R	42	47	28
Resident and Passage migrant	R/P	2		
Resident and Summer visitor	R/S	3		
Winter visitor	W	16	27	16
Winter and Passage migrant	W/P	11		
Summer visitor	S	15	23	14
Summer and Passage migrant	S/P	1		
Rains visitor	V	7		
Passage migrant	P	26	38	23
Passage, mainly autumn	Pa	8		
Passage, mainly spring	Ps	4		
Occasional, non-seasonal	O	32		19
		167		

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CEREAL PREFERENCE AND INTAKE OF FOUR SPECIES OF FIELD RODENTS[1]

SHAKUNTHALA SRIDHARA[2] AND R. V. KRISHNAMOORTHY

(*With a text-figure*)

The preference and intake of different grains and standard rat and mice feed and the effect of texture were assessed in four species of rodents namely *Bandicota bengalensis bengalensis* Gray, *Rattus rattus* Linn, *Rattus meltada* Gray and *Tatera indica cuvieri* Waterhouse. The calorific and nutritional value of the food, effect of habitat, activity of the animal, body weight and palatability of the grain offered all affected preference and consumption. These studies suggest that for wetlands and residential area a bait composed of rice-ragi should be used for control by poisoning and for drylands a jowar-maize bait would be more acceptable.

INTRODUCTION

Although some field and laboratory studies on food selection and preference of rodents have been conducted (Prasad, 1954; Prakash, 1962; Parrack, 1969; Prakash *et al.*, 1970; Bindra & Sagar, 1976 Jain *et al.*, 1974; Prakash *et al.*, 1974; Khan 1974) more information is needed for a variety of species. Such studies would be of great help in formulating bait composition for field control. The present investigation therefore examined the feeding preferences of *Bandicota bengalensis bengalensis* Gray, *Rattus rattus* Linn. *Tatera indica cuvieri* Waterhouse and *Rattus meltada* Gray. Preferences for different cereals and the effect of texture of grain on preference were assessed.

METHODS

Adult lesser bandicoots (6 ♂♂ and 6 ♀♀) were trapped in paddy fields; soft-furred field rats and gerbils (3 ♂♂ and 3 ♀♀ of each) were captured in cultivated ragi fields. Black rats (5 ♂♂ and 5 ♀♀) were trapped in the residential area near the University campus. All the rats were housed individually in metal cages. Each cage was provided with cotton wool and hay for bedding. Photoperiod was regulated at 12 hours light and 12 hours darkness with the light period starting at 06-00 hrs. Air temperature varied at 23±2°C.

Cereal preference: The cereals were offered in a socket-cylinder type of container. The inner component was a cylinder with 8 cm diameter, 4.5 cm in height with a 4.4 cm circular opening in the centre. The inner container fitted into the outer component which was fixed to the floor of the cage. The devise greatly reduced spillage of grain.

'No choice experiment': Consumption of locally grown rice (*Oryza sativa*), ragi (*Eleusine coracana*), wheat (*Triticum aestivum*), jowar (*Sorghum vulgare*) and maize (*Zea-mays*) were tested in that order, each cereal for seven consecutive days. Similarly the rate of consumption of standard rat and mice feed (Hindustan Lever, India) was estimated and compared with cereal intake. Water with added 2% multivitamins (Multivitamin syrup,

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Glaxo Laboratories Pvt. Ltd., India) was always available. Food consumption was expressed as g/100 g body weight/24 hrs. and its calorific equivalent.

Paired choice experiment: Rice was paired with ragi, wheat, jowar and maize. For preference between two cereals, two separate containers containing 40 g each of the cereals were placed in diagonally opposite corners of the cage. Consumption of each cereal was measured as before.

Texture choice: Each test grain was offered in three forms-as whole grain, broken grain and powder form in three different containers simultaneously and the preference towards texture studied.

Activity scores: The rats of each species were observed for ten minutes each day individually for five days at 10 A.M. to overcome the effect of diurnal rhythms. During the ten minute counts of sniffing, drinking water, eating, exploring the cage, climbing and running were recorded.

TABLE 2

RATE OF COMMERCIAL FEED CONSUMPTION AND ITS CALORIFIC EQUIVALENT IN FOUR SPECIES OF WILD RODENTS

Species	Pellets consumed g/100g body weight	Calorific equivalent of consumed pellets	Body weight (Range)
B. bengalensis	12±1.8	38.4	250–300
R. rattus	10±0.9	32.0	150–200
T. indica	11±1.6	35,0	130–150
R. meltada	10±1.5	32	70–100

Values are mean of the means of each week observations ± S.E.

TABLE 1

INTAKE OF DIFFERENT CEREALS BY FOUR SPECIES OF RODENTS

(*B. bengalensis*, *R. rattus*, *T. indica* AND *R. meltada*)

Species	RICE g/100g	RICE cal	RAGI g/100g	RAGI cal	WHEAT g/100g	WHEAT cal	JOWAR g/100g	JOWAR cal	MAIZE g/100g	MAIZE cal	Mean grain intake	Mean cal. intake
B. bengalensis	6±1	21±4	5±0.5	17±2	5±0.5	17±2	4.8±1	17±3	4.5±0.3	15±3	5±0.2	18±1
R. rattus	12±0.8	41±3	11±0.8	35±3	9±0.4	31±2	7±0.6	24±2	11±1	38±3	10±0.8	34±2
T. rndica	14±1	48±3	18±6	59±5	12±1.8	41±6	16±1.5	56±5	21±4	73±1	16±1.5	55±7
R. meltada	8±1.5	28±5	16±0.8	53±3	14±1.8	48±6	12±1.7	42±5	16±2	55±6	13±1	45±4

p >.001

Values are mean of the means of each week of observations ± S.E.

Statistical analysis: Student's 't' test (Croxton 1953), Friedman's two-way analysis of varience by ranks and Krushkal-Wallis one way analysis of varience by ranks (Seigel 1956) were used to compare the preferential intake of cereals, the effect of texture on preference and activity scores respectively.

RESULTS

B. bengalensis: In the absence of any choice the lesser bandicoot consumed more rice than each of the other cereals. Ragi and wheat were eaten more than jowar and maize (Table

TABLE 3

INTAKE OF CEREALS BY FOUR SPECIES OF RODENTS WHEN PAIRED CHOICE OF CEREALS WAS OFFERED

	Rice	ragi	RICE vs. p	RAGI Preference	total cereal intake	total cal. intake
bengalensis	4,2±0.9	3.2±0.4	=0.2	rice & ragi	7.4	25
rattus	6.0±1.0	4.5±1.0	>0.2	rice & ragi	10.5	35
indica	1.5±0.5	9.5±2.0	>.01	ragi	11.0	37
meltada	2.5±0,5	7.5±0.8	>.01	ragi	10.0	33
			RICE vs. WHEAT			
bengalensis	4.0±0.7	1.8±0.5	>.001	rice	5.8	20
rattus	6.3±0.2	1.6±0.3	>,001	rice	7.8	28
indica	6·3±1.0	2.7±0.5	>.05	rice	9.0	31
meltada	6.0±1.0	3.0±0.8	>.05	rice	9.0	31
			RICE vs. JOWAR			
bengalensis	4.5±0.3	0.7±0.2	>.001	rice	522	19
rattus	5.7±1.0	5.5±0.2	>.1	rice & jowar	11.2	37
indica	4.2±0.5	7.7±1.3	>.05	jowar	12.0	42
meltada	4.5±1.0	6.5±0·5	>.05	jowar	11.0	38
			RICE vs. MAIZE			
bengalensis	4.0±0.6	0.8±0.3	>.001	rice	4.8	16
rattus	7.4±0.6	0,6±0.5	>.001	rice	8.0	28
indica	5.0±0.5	3.5±0.8	>.05	rice	8.5	30
meltada	6.5±1.0	2.5±1.0	>.02	rice	8.0	31

Fadings are the mean of means of 7 observations ± S.E.

1). Bandicoots however, ate less grain than commercial feed (Table 2). In paired choices they preferred rice and ragi than wheat, maize and jowar (table 3). Rice was prefered to all other grains except ragi. No preferential order was noticed. Similar results were reported by Spillett (1968) for lesser bandicoots. Rice-ragi combination was highly consumed (Table 3). The grain consumption was higher when more than one grain was present (Table 1 and 3). Bindra & Sagar (1970) observed the same trend in lesser bandicoots. Grain in powder form was preferred to broken or whole grains (Table 4).

Lesser bandicoots registered the lowest level of physical activity (Table 5).

R. rattus: Black rats ate more rice, ragi and maize than wheat and jowar when there was no choice (Table 1). Compared to lesser bandicoots, they consume less commercial feed (Table 2), but twice as much grain (Table 1). When a choice was offered they prefered rice followed by ragi and jowar, wheat and maize (Table 3). Earlier black rat's preference towards rice when offered along with four other food stuffs was observed by Harrison & Woodville (1950). The rate of intake was not affected by the presence of more than one grain (Table 3). Krishnamurthy *et al.* (1967) noticed similar trend in black rats. Rice and jowar combination was liked more than any other pair of cereals (Table 3). Powdered grain was prefered to broken or whole grain (Table 4).

Activity scores were higher than that of

TABLE 4

EFFECT OF CEREAL TEXTURE ON CONSUMPTION RATES OF WILD RODENTS

		RICE	RAGI	WHEAT	JOWAR	MAIZE
B. bengalensis	a.	0.9±0.1	0.0	0.4±0.3	0.3±0.1	0.3±0.2
	b.	3.6±0.5	0.8±0.1	1.7±0.3	1.3±0.3	1.9±0.5
	c.	3.9±0.8	7.0±1.4	4.9±0.3	6.5±0.5	4.4±0.4
	d.	8.4±0.7	7.8±1.5	7.1±0.6	8.1±0.5	6.7±0.6
R. rattus	a.	2·3±0.5	0.0	0.7±0.6	2.3±0.8	0.5±0.2
	b.	1.9±0.6	2.7±0.5	0.6±0.1	0.5±0.2	0.2±0.04
	c.	5.5±1.2	9.0±0.5	8.0±0.7	9.5±0.6	3.8±2.0
	d.	9.7±1.0	12±0.9	9.3±0.8	12.2±1.2	4.5±1.5
T. indica	a.	1.5±0.02	0.0	5.0±0.6	4.0±0.7	3.1±1.0
	b.	0.8±0.3	6.9±1.0	3.0±0.6	3.0±0.4	0.7±0.3
	c.	7.3±0.2	4.3±1.0	9.0±0.7	7.0±0.6	8.1±1.3
	d.	9.6±0.2	11.8±0.8	17.0±0.6	14.0±1.0	12.0±1.4
R. meltada	a.	2.0±0.3	0.0	0.8±0.3	1.8±0.5	0.6±0.1
	b.	1.5±0.2	1.9±0.4	2.2±0.4	0.9±0.3	2.2±0.5
	c.	5.9±0.5	8.5±0.3	6.0±2.0	9.2±0.5	4.2±0.5
	d.	9.4±0.5	10.4±0.4	8.8±1.5	11.9±0.6	7.0±2.0
		$p>.0046$	$p>.0046$	$p>.0046$	$p>.0046$	$p>.0046$

Values are mean of the means of 7 observations ± S.E.

a, whole grain; *b*, broken grain; *c*, powder form of the grain; *d*, total consumption.

lesser bandicoots but below that of gerbils (Table 5).

T. indica: Gerbils ate more maize than any of the other grains (Table 1) when there was no choice. The order of intake was maize > ragi > jowar > rice > wheat. Next to lesser bandicoots, they consume the highest amount of commercial feed (Table 2). Mean grain consumption was highest in gerbils (Table 1).

When faced with a paired choice the decreasing order of preference was: ragi-jowar; rice; wheat-maize (Table 3). Rate of consumption was more when there was no choice (Tables 1 and 3) in contrast to earlier studies of Bindra & Sagar (1970). Rice and jowar combination was the most preferred pair (Table 3).

Powdered grain was the most liked but the extent of preference towards whole grain was more in gerbils than in other species tested (Table 4).

Highest physical activity was seen in gerbils (Table 5).

R. meltada: The soft-furred field rats preferred all the grains except rice (Table 1). When offered a paired choice, preference for ragi and jowar was seen followed by rice, maize and wheat (Table 3). Rate of consumption was more when there was no choice (Table 1 and 3) .Earlier it was reported that single or multiple choice had no effect on average daily intake of food (Jain *et al.* 1974). Rice and jowar combination was the best liked (Table 3). Powder form was preferred to other forms of grain offered (Table 4).

Activity scores were similar to black rats (Table 5).

Calorific intake: The data presented in fig. 1 illustrates that gerbils consume more calories than other species followed by *R. meltada*, *R. rattus* and *B. bengalensis.*

Table 5

Activity scores of wild rodents under captive conditions

Species	Activity scores
B. bengalensis	15±3
R. rattus	26±3
T. indica	35±5
R. meltada	25±3

>.001

Values are mean of the means of observations ± S.E.

Discussion

Though most rodents are omnivorous and versatile feeders, different species exhibit subtle differences in their food preferences (Landry 1970; Barnett 1966). Exploratory capacity and learning behaviour help rats adapt themselves to changing situations (Barnett 1975). However, factors which influence the food selection and food detection are not well known.

Food preference may be affected by the nutritive value of the food. Since the calorific values of the foods offered in the present experiment ranged from 3.2 to 3.6 calories per gram (Aykroyd 1976), the influence of the calorific value of the food on preferential intake was probably negligible. *B. bengalensis* consumed twice as much commercial feed as cereals though the calorific values are about equal. Probably the commercial feed was more palatable, nutritive or more easily eaten.

Food preference is also affected by the earlier experience of the animal (Forgus & Hutchings 1960); such an effect was not

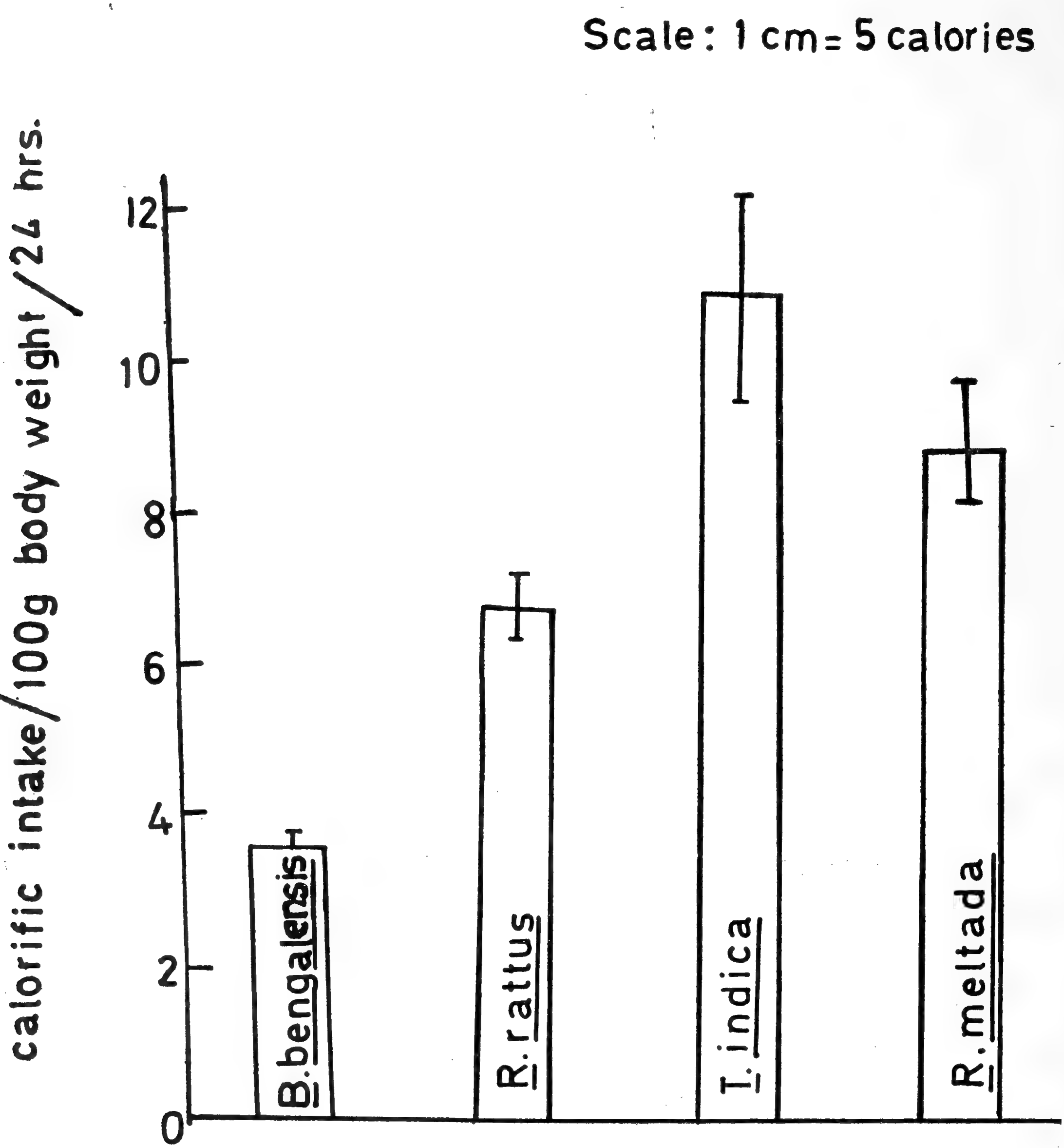

Fig. 1. Average calorific intake in field rodents.

however found by Bronson (1966) or Krishna Kumari (1973). But Barnett (1966) suggests that given a choice rats tend to select the food with which they are most familiar. *B. bengalensis* inhabits clay loam soils and wet paddy fields (Srivastava *et al.* 1968; Urs *et al.* 1968; Sridhara 1976) where rice is readily available; thus their preference for rice and ragi in the laboratory. In case of *R. rattus,* its preference for rice may again result from its earlier experience of that food since rice was the staple food of people in the area from which the black rats were captured. Their liking for ragi and jowar may be due to the small size and smooth consistency of these grains (Khan 1974). Both *T. indica* and *R. meltada* inhabit a wide variety of dryland habitats (Urs *et al.* 1968; Chandrahas & Krishnaswamy 1974) and in the present study were collected from ragi fields; hence their preference for dryland crops.

Food consumption is also influenced by the physical activity of the animal. Laboratory observations showed gerbils as the most active rodents followed by *Rattus* genera and bandicoots. Comparison of average grain intake (Table 1) and calorific intake (Figure 1) shows that a correlation can be drawn between the two.

Food consumption is related to bodyweight; food eaten per gram of body weight declines however with increasing body weight (Barnett 1975). Thus energy requirements of the animals are generally inversely proportional to body weight and calorific intake is greater in animals of low weight (*R. meltada* and *T. indica*) than in *B. bengalensis* (Table 2).

Texture preferences are purely due to palatability reasons since rats often prefer soft or finely divided food to hard or coarse grain (Barnett & Spencer 1953; Jain *et al.* 1974; Prakash *et al.* 1974). All the four species studied confirmed this (Table 4).

Rodents are characterised by 'Omnivory' and 'Sampling' of all available food in their environment (Barnett 1975). All the four species always sampled all available foods but in quantities related to nutritive values of the food, palatability, earlier food experience, physical activity and body weight.

Basing on present results it can be suggested that a bait of rice and ragi should be most effective for control of *B. bengalensis.* For the dryland species *R. meltada* and *T. indica* a jowar-maize bait and for the commensal black rat a rice-ragi or rice-jowar bait should be used.

Acknowledgements

We are indebted to Dr. K. Ramakrishnan, Dean, University of Agricultural Sciences, Bangalore for encouragement and Dr. R. Narayana, Director of Instruction (Basic Sciences & Humanities), University of Agricultural Sciences, Bangalore for offering facilities. Financial aid from the Ford Foundation (Grant No. 660-19B), New Delhi is gratefully acknowledged. Thanks are due to Dr. P. E. Cowan for critically going through the manuscript and for suggestions.

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THE EFFECTS OF FOOD DEPRIVATION AND SATIETY ON THE SWIMMING ACTIVITY OF AN AQUATIC COPEPOD, *ORTHOCYCLOPS MODESTUS* (CRUSTACEA: COPEPODA)[1]

FRED PUNZO[2]

(*With two text-figures*)

Food deprivation for 48 h does not significantly affect the swimming activity of *Orthocyclops modestus*. Prolonged food deprivation (10 days) results in a significant decrease in activity presumably due to physiological deterioration. Satiety results in an almost immediate cessation of swimming movements which possibly reflects an adaptive mechanism that increases the survival capacity of the species.

One of the most common behavioural responses to food deprivation characteristic of vertebrate animals is an increase in the general level of activity (Bolles 1967; Finger & Mook 1971; Wald & Jackson 1944), coupled with a corresponding increase in willingness to perform certain tasks reinforced by the attainment of food (Beukema 1963; Cofer & Appley 1964; McFarland 1965; Mrosovsky 1964; Smith & Capretta 1956). For example, it has been demonstrated with rats that their rate of performance on an instrumental task (bar pressing) for an equal amount of food reward is inversely proportional to the degree of satiety of the animal (Bolles 1967; Mackintosh 1973; Miller 1955). Previous investigations, although scarce, seem to suggest that invertebrates do not exhibit this direct relationship between the level of hunger and general level of activity (Barton & Evans 1960; Breland & Breland 1966; Marler & Hamilton 1966). The blowfly, *Phormia regina,* although capable of registering satiety *via* mechanoreceptors located in the wall of the alimentary canal which are stimulated by a distension of the gut following feeding, is unable to register degrees of hunger (Dethier 1961; Dethier & Bodenstein 1958; Dethier, Bodenstein & Rhoades 1956; Evans & Browne 1960). As a result, this insect can only discriminate between satiated and non-satiated states, whereas vertebrates can differentiate between various degrees of hunger (Beukema 1963; Bolles 1967; Mackintosh 1973; Prosser & Brown 1961; Tugenhadt 1960). Similar findings have been reported for the cockroach (Reynierse, Manning & Cofferty 1972), and only two additional invertebrates: the amphipods *Marinogammarus marinus* (Fincham 1972) and *M. obtusatus* (Mackintosh 1973; Martin 1966), and the isopod *Eurodica pulchra* (Jones & Naylor 1970). In view of this fact, the present study was conducted in order to investigate the effects of hunger and satiety on the swimming activity of *Orthocyclops modestus* (Crustacea: Copepoda), and to then compare these results with those reported for the few species previously mentioned. Information of this nature is not currently available for this group of crustaceans. *O. modestus* is an aquatic copepod universally distributed throughout the plankton and littoral regions of fresh waters

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(Culver & Brunskill 1969; Elton 1929). Copepods are basically omnivorous, their food consisting of unicellular plant and animal material as well as decaying organic material (Pennak 1953; Wilson 1932).

Method

Subjects:

The Ss consisted of adult male *Orthocyclops modestus,* ranging from 0.7 to 1.2 mm in length. They were collected from a small pond 14 km south of Galena, Stone Co., Missouri. The animals were maintained in constant temperature cabinets at 16°C, and kept on a normal photoperiod regime (12L:12D). They were housed in white porcelain trays containing pond water from the original collecting site, and provided with algae and corn meal daily. The animals were allotted a period of one month to adjust to laboratory conditions before being tested.

Apparatus:

The apparatus consisted of a circular swimming chamber similar to that described by Fincham (1972) and Mackintosh (1973). A glass bowl, 15 cm in diam. and filled to a depth of 5 cm with filtered pond water, was utilized as the swimming chamber. The Ss were introduced individually into the chamber and allowed to swim. Affixed to the bottom of the chamber was a circular paper grid on which were drawn 12 equidistant radii. Swimming activity was measured as the number of line crossings made by an individual in either direction during a given period of time. Water temperature was maintained at a temperature equivalent to that normally encountered by these animals (18° ± 1°C) by the use of a controlled water bath.

Procedure:

The Ss were divided into two experimental series. The purpose of the first series was to ascertain the effects of food deprivation on swimming activity. Twenty Ss, deprived for 48 h, were tested individually in the swimming chamber (Group 1). Tests with the experimental animals were alternated with tests on a group of 20 normally-fed (non-deprived) Ss serving as controls. A second experimental group of 10 Ss was deprived of food for 10 days and tested in the same way (Group 2), again with alternated tests on 10 non-deprived controls. Swimming activity was recorded over a period of 30 min in 5-min subtotals.

In the second experimental series, the effects of satiation and food deprivation on swimming activity were investigated. Three groups, each consisting of 10 Ss, were tested under the following feeding conditions: normally-fed, 5-day food-deprived, and satiated. Satiation was achieved by allowing the Ss to feed ad lib for 3 h in the swimming chamber prior to testing. Each S was confined in a small plexiglass container and provided with algae and corn meal. The Ss tested under the deprived and normally-fed conditions were also confined for a 3-h period in the absence of food material in order to control against any possible effects of confinement. After this 3-h period, the Ss were removed from the plexiglass holder and their swimming activity was recorded as previously described.

Results

The results of Fig. 1 show that no significant difference was found between the swimming activity of Group 1 animals (48-h deprivation) and the normally-fed controls. However, individuals from Group 2 (10-day deprivation) exhibited a marked decrease in

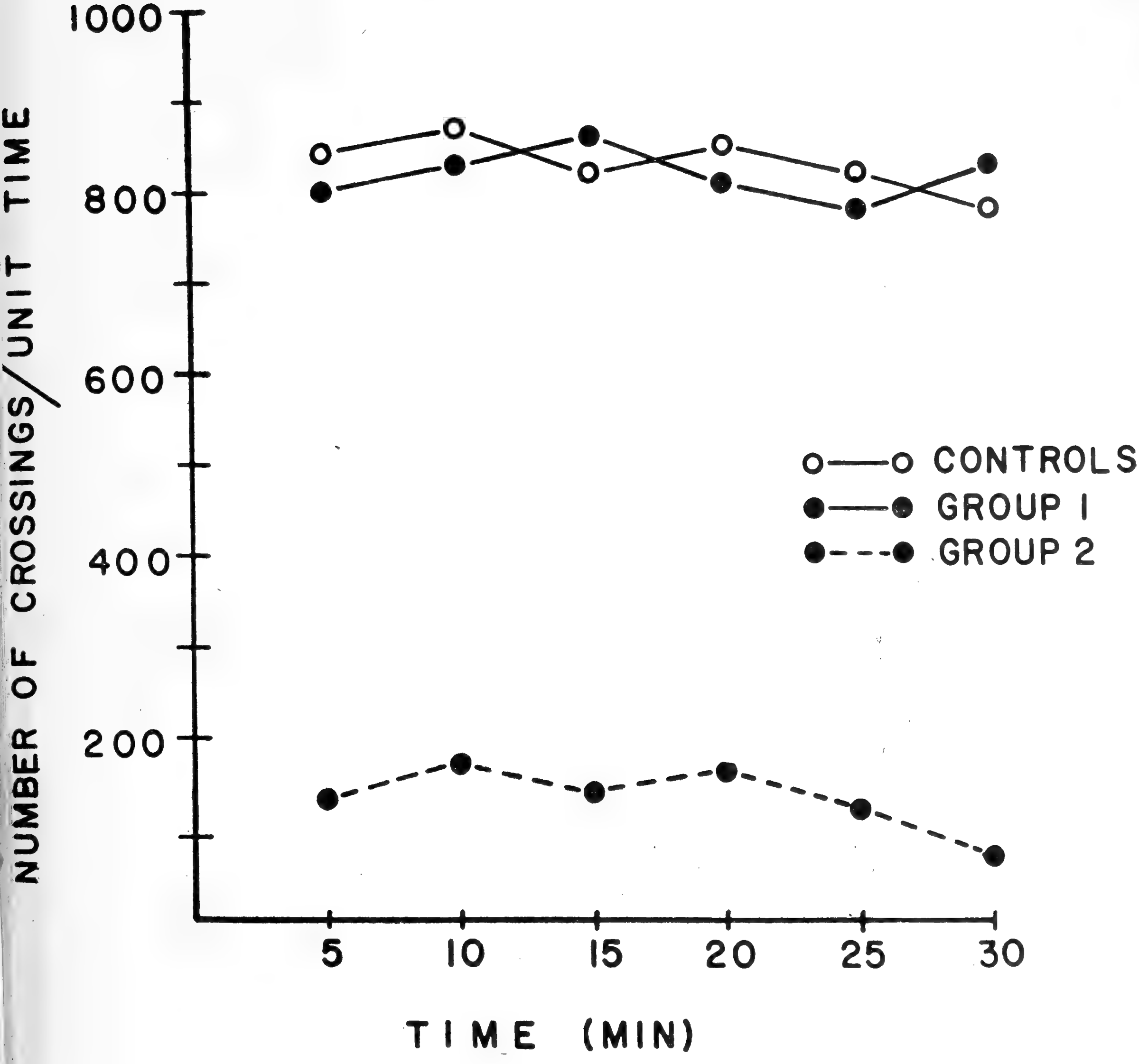

Fig. 1. The effects of 48 hr (Group 1) and 10 days (Group 2) food deprivation on the swimming activity of *O. modestus* as compared to that of normally-fed controls.

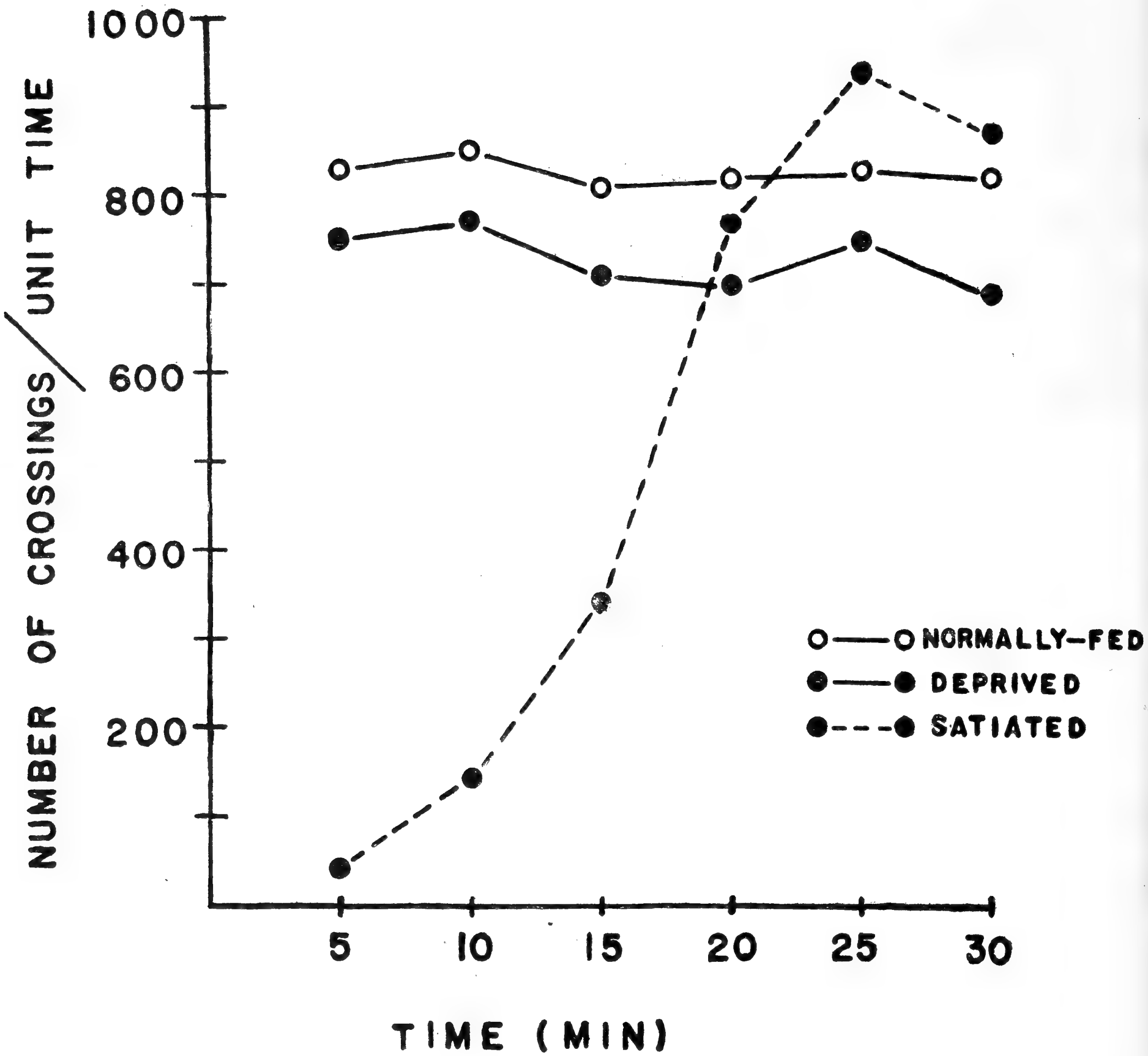

Fig. 2. The effects of satiety on the swimming activity of *O. modestus* as compared to deprived (5 days) and normally-fed individuals.

swimming activity vs. the controls (Mann-Whitney U-Test: z = 4.71; $p < 0.01$).

From the results shown in Table 1 and Fig. 2 it is evident that satiation reduced swimming activity during the first 15 min. Although the swimming activity between the three groups over a 30-min period did not differ significantly, if the initial 15 min of the experiment are analyzed, values for satiated individuals are significantly below those for the deprived and normally-fed Ss. Observation of the copepods revealed that satiated animals were highly sedentary during this initial period.

Discussion

The results recorded in Fig. 1 show that prolonged food deprivation (Group 2) not only failed to increase general bodily activity, but actually resulted in a significant decrease in swimming behavior. This is in agreement with findings reported for amphipods (Fincham 1972; Mackintosh 1973). Since this deprivation effect increased with time it can presumably be attributed to some physiological deficiency. Group 1 Ss, deprived for a period of time of insufficient duration to cause physiological deterioration (48 h), exhibited no significant difference in swimming activity over that demonstrated by the controls. This is further substantiated by the results shown in Fig. 2 for Ss deprived for 5 days, also a period of time insufficient to cause physiological deterioration (Pennak 1953). It can be concluded therefore, that within the limits of physiological tolerance, food deprivation does not result in an increase in bodily activity for *O. modestus*. This is in direct contrast to the response of vertebrates which is characterized by a significant increase in the general level of activity within physiological limits of tolerance (Barton & Evans 1960; Bolles 1967; Finger & Mook 1971; Marler & Hamilton 1966). It is evident therefore, that the behavioural responses to hunger exhibited by some invertebrates are very different from those charactristic of vertebrate animals. Future investigations on many invertebrate species should be undertaken in order to further substantiate this conclusion.

The results in Table 1 and Fig. 2 show that satiated individuals were characterized by an initial significant decrease in swimming activity. However, in this case, the inhibition of activity appears to be due to a modification of behaviour rather than to any physiological deterioration since activity increased after the first 15 min. It is possible that this intial decrease in mobility is indicative of a more general adaptive mechanism. Barton & Evans (1960) have reported that blowflies which have never previously been fed exhibit spontaneous locomotor activity; this activity is markedly reduced immediately after feeding. This has also been verified for locusts (Ellis & Hoyle 1954) and amphipods (Mackintosh 1973). It is well known that hunger induces exploratory and foraging behaviour in animals (Campbell & Sheffield 1953: Fowler 1965; McFarland 1965; Mrosovsky 1964) which ultimately terminates in a consummatory response (Bolles 1967; Cofer & Appley 1964). However, once an organism has fed and food-seeking behaviour is no longer necessary, the survivability of the organism is increased if locomotion is inhibited. Any mechanism which reduces activity thereby rendering the animal less conspicuous to potential predators, is of important adaptive significance. *O. modestus* responds to satiation by an immediate drastic reduction in swimming activity. Since copepods are a potential food source for numerous aquatic predators, such an immobilization would effectively decrease the level of

predation and as a result increase the survival capacity of the species. Unlike the hunger response, with respect to satiety *O. modestus* exhibits a decrease in activity similar to that found in vertebrates.

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IMAGO CASTE OF *NEOTERMES MEGAOCULATUS MEGAOCULATUS* ROONWAL ET SEN-SARMA (ISOPTERA: KALOTERMITIDAE) FROM KUMAON HILLS, UTTAR PRADESH[1]

M. L. THAKUR[2]

(*With a text-figure*)

INTRODUCTION

Roonwal & Sen-Sarma (1960) recorded seven species and two subspecies of genus *Neotermes* from the Indian Region. Since then, four more species have been added by Roonwal & Verma (1971), Maiti (1975), Sen-Sarma & Thakur (1978) and Thakur (in press). Of these, the imago caste is known only in five species. While indentifying the termite collection from Kumaon Hills, I came across a vial containing five imagos, two soldiers, a few pseudoworkers and imago nymphs. The detailed examination of the material reveals that it belongs to *Neotermes megaoculatus megaoculatus* Roonwal *et* Sen-Sarma. The imago caste of which is hitherto unknown in this subspecies, and is described here. Incidentally this happens to be a new locality record for this subspecies. Earlier it was known only from its type-locality Dehra Dun, Uttar Pradesh and the present record therefore, extends the range of its distribution.

MATERIAL

One vial (B114/29.5.71) with five imagos, 2 soldiers and a few pseudoworkers, from Kanda Dhar Forest (1350 m, above sea level), Kanda, Kumaon Hills, Uttar Pradesh, Coll. B. K. Gupta, 29-5-1971. Ex. *Mangifera indica.*

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DESCRIPTION

I—**Imago** (Fig. 1; Table 1)

General: Head-capsule pale brown to deep brown; antennae, labrum and pronotum brown; postclypeus of same colour as dorsum of head-capsule; body brownish yellow, paler than head-capsule. Head-capsule and pronotum sparsely pilose, with long hairs. Total body-length without wings *c* 10.00-11.90 mm; with wings *c* 19.35-20.40 mm.

Head: Head-capsule suboval, sides gradually converging posteriorly; slightly broader than long (upto lateral base of mandibles); posterior margin roundish; frons declivous; Y-suture distinct. *Eyes*: Large, subcircular, separated from antennae by a distance of about 0.05 mm. *Ocelli*: Large, translucent, oval, broadly touching the ocular sclerites. *Antennae*: 19-segmented (in one specimen, left antenna 18-segmented); segment 2 cylindrical, broader and usually one-and-a half times as long as 3; 3 longer than 4; 3-6 narrower than succeeding segments; 7 to 14 gradually becoming broader and globular shape; 15 to penultimate gradually becoming pyriform; last oblong and much narrower than penultimate. In 18-segmented condition, segment 2 only slightly longer than 3; 4 subequal to 5. *Clypeus*: Postclypeus small, subrectangular. Anteclypeus trapezoid; anterior margin weakly projecting in the middle. *Labrum*: Tongue shaped, tip and body pilose with long and short hairs; anterior margin subrounded. *Mandibles*: Of *Neotermes* type.

PLATE I

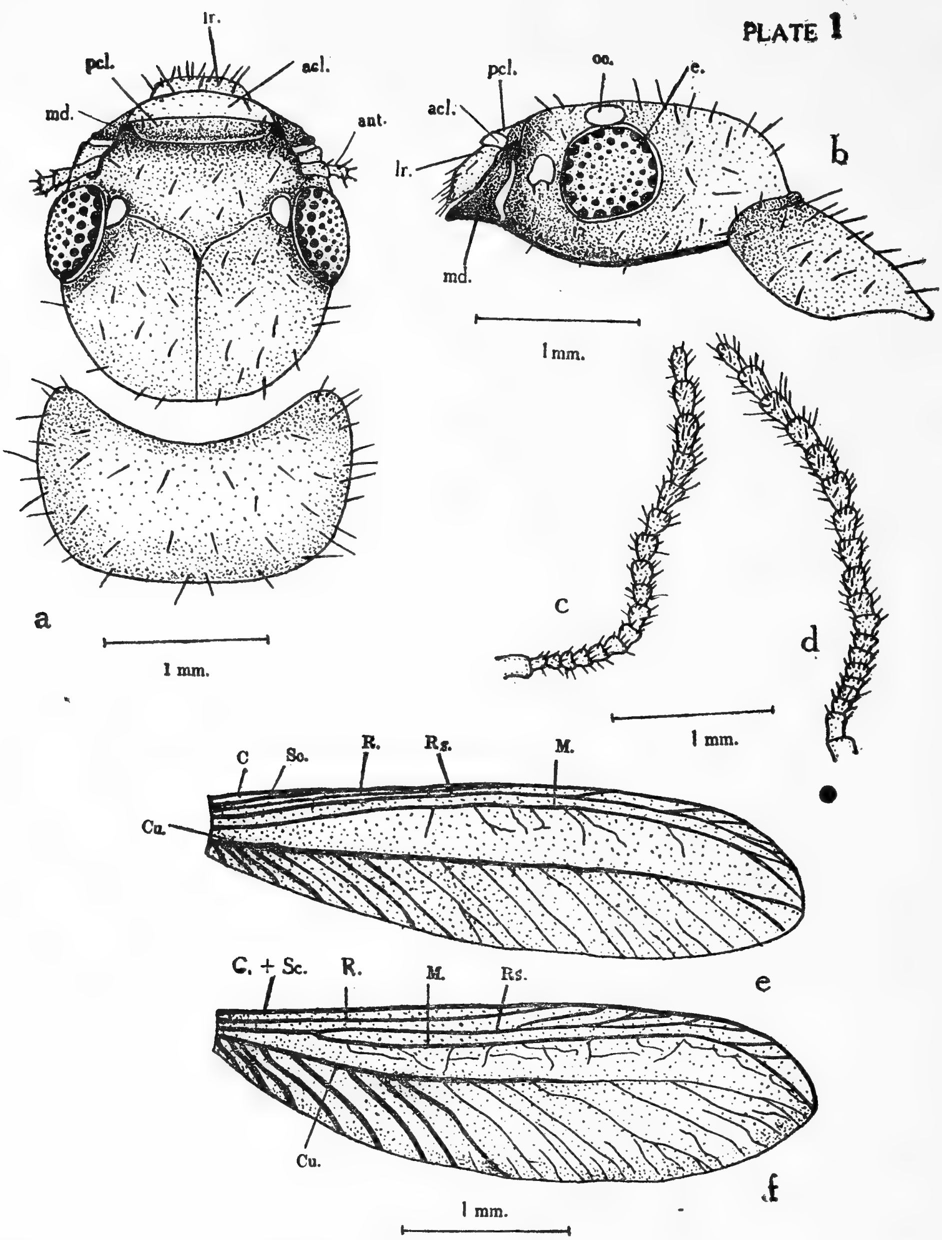

Fig. 1. *Neotermes megaoculatus megaoculatus* Roonwal et Sen-Sarma (a) Head and pronotum, in dorsal view; (b) Head and pronotum, in side view; (c) Left antenna (18-segmented); (d) Right antenna (19-segmented); (e) Forewing; (f) Hind wing. *Abbreviations*: acl., anteclypeus; ant., antenna; C., Costa; C + Sc., Costa-Subcosta; Cu., Cubitus; e., eye; lr., labrum; md., mandible; M., Median; pcl., postclypeus; R., Radius; Rs., Radial sector; Sc., Subcosta.

Thorax: *Pronotum*: Subrectangular; distinctly broader than head-width across the eyes; anterior margin broadly concave; posterior margin substraight. *Legs*: Slender, elongate and hairy; tibial spurs 3:3:3; tarsi 4-segmented.

Wings: Wing membrane non-pigmented in the distal half, weakly tuberculate. *Forewing*: Scale much longer than in hindwing. Costa thick, pigmented and bordering the anterior margin. Subcosta short, extending only a short distance and fusing with Costa near the proximal third of wing membrane. Radius prominent, unbranched, extending upto nearly half of wing membrane without scale. Radial Sector prominent, well pigmented in the proximal half, with 7-8 branches towards the Costa. Median well pigmented running close to and parallel with Radial Sector, with 5-7 short transverse branches. Cubitus with 12-15 main branches, of which the proximal 5-7 well pigmented, rest colourless. *Hindwing*: Scale very small. Costa-Subcosta fused and bordering the anterior margin of wing. Radius prominent, well pigmented, extending a little more than half of wing membrane, where it meets Costa-Subcosta. Radial Sector with *c* 5-7 branches in the distal half. Median arising from the Radial Sector at about 1/5 the length of wing. Cubitus with 11-14 branches.

Abdomen: Elongate, hairy, Cerci 2-segmented, hairy.

TABLE 1

BODY MEASUREMENTS (IN MM) OF 4 IMAGOS OF *Neotermes megaoculatus megaoculatus* ROONWAL ET SEN-SARMA

Body parts	Range	Mean
	I—General	
Total body-length without wings. *c.*	10-00-11.90	10.60
Total body-length with wings. *c.*	19.35-20.40	19.70
	II—Head	
Head-length with mandibles	2.10- 2.50	2.22
Head-length to lateral base of mandibles	1.75- 1.90	1.85
Maximum width of head (with eyes)	1.95- 2.15	2.04
Height of head	1.10- 1.28	1.18
Maximum diameter of eye (with ocular sclerites)	0.65- 0.73	0.69
Minimum diameter of eye	0.63- 0.70	0.65
Maximum diameter of ocellus	0.25- 0.30	0.27
Minimum diameter of ocellus	0.20- 0.23	0.21
Minimum eye-antennal distance	0.05	
	III—Thorax	
Length of pronotum	1.05- 1.20	1.12
Maximum width of pronotum	2.00- 2.20	2.13
Length of fore wing with scale	16.00-17.30	16.70
Length of fore wing without scale	14.10-15.50	14.80
Length of fore wing scale	1.80- 2.00	1.88
Length of hind wing with scale	14.00-16.00	14.90
Length of hind wing without scale	12.90-15.00	13.80
Length of hind wing scale	0.80- 1.20	0.95

Comparison

The imagos of *N. megaoculatus megaoculatus* are very close to *N. bosei* Snyder, but differ as follows.

(i) Comparatively larger species (ii) Antennae 18-19 segmented *vs.* 17-18 segmented and (iii) Pronotum distinctly broader than head-width across the eyes.

Remarks on soldiers:

I have compared the soldiers from Kumaon Hills with paratypes of *Neotermes megaoculatus megaoculatus* present at the Forest Research Institute, Dehra Dun, and have noted the following points.

The soldiers from the present lot agree very well with paratypes both morphologically as well as bio-metrically, however they differ in certain respect from the paratypes and which may well be taken as locality variations, as such differences are not uncommon in the genus *Neotermes.*

Head-capsule comparatively smaller; Y-suture distinct; marginal teeth comparatively small and blunt. Antennae with 15-16 segments; in 15-segmented condition, segment 3 more chitinised and longer than 2; in 16-segmented antennae, 2 slightly longer than 3. Pronotum (*in situ*) distinctly broader than head-width (Pronotum-head width index 1.037-1.04).

Table 2

Body measurements (in mm) and indices of 2 soldiers of *Neotermes megaoculatus megaoculatus* Roonwal et Sen-Sarma

Body-parts	Range
I—*General*	
Total body-length *c.*	13.10-14.00
II—*Head*	
Head-length with mandibles	5.60-6.10
Head-length to lateral base of mandibles	3.60-3.90
Maximum width of head	2.60-2.70
Height of head	1.95-2.20
Head-index—I. (width/length without mandibles)	0.69-0.72
Maximum diameter of eyes (a) Left eye	0.33-0.38
(b) Right eye	0.30-0.33
Minimum diameter of eyes (a) Left eye	0.20-0.23
(b) Right eye	0.18-0.20
Length of mandibles (a) Left mandible	2.00-2.20
(b) Right mandible	1.90-2.20
Head-mandibular index (Left mandible length/ head-length to lateral base of mandibles)	0.56
III—*Thorax*	
Length of pronotum	1.10-1.25
Maximum width of pronotum	2.70-2.80
Pronotum-head-width index (Pronotum width/ head-width)	1.037-1.04

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FOOT-WETTING AND BELLY-SOAKING BY INCUBATING GULL-BILLED TERNS AND BLACK SKIMMERS[1]

GILBERT S. GRANT[2]

(*With a text-figure*)

While investigating breeding adaptations to high temperatures in charadriiform birds at Salton Sea, California, U.S.A. foot-wetting and belly-soaking, two interesting and previously unrecorded incubation behaviours, were observed in Gull-billed Terns (*Gelochelidon nilotica*) and Black Skimmers (*Rynchops niger*). Foot-wetting is simply the dipping of the feet and lower legs into the water by the incubating birds while in flight (Turner & Gerhart 1971) and belly-soaking, as defined by Maclean (1975:74), "consists of wetting the belly feathers for the purpose of transporting water to eggs or chicks."

Salton Sea is a large, man-made saline lake about 70 m below sea level in the Sonoran Desert of Southeastern California. Observations were made in 1975 at a skimmer nesting site at the north end of the sea (Grant & Hogg 1976), and in 1976 at skimmer and tern nesting sites along the Acorn Barnacle (*Balanus amphitrite*) bars of the southeast corner of the sea and at the Imperial Wildlife Area near Niland. Intense solar radiation, daytime shade temperatures (T_A) above 40°C, soil temperatures near the nests in excess of 50°C, and almost total lack of cloud cover characterize the area during the mid-summer breeding season.

Gull-billed Tern.—On 24 June 1976 at 1258 (T_A = 40.8°C) a Gull-billed Tern flew into my study area from an adjacent dry impoundment of the Wister Unit of the Imperial Wildlife Area, foot-wetted three times and drank three times while on the wing, then returned immediately to the impounded area. A tern coming from the same area foot-wetted once and drank once at 1311 (T_A = 39.8°C). At 1338 (T_A = 40.0°C) a tern flew into view, landed in belly-deep water, remained in the water for about 15 seconds without rocking, and flew to a mudflat and preened. I did not see another foot-wetting episode until 1523 (T_A = 40.3°C). I may have missed some foot-wetting bouts because my attention was focused on other nesting birds during this and the following days. At 0910 (T_A = 31.0°C) on 25 June 1976 a tern flew in from the same area as on 24 June, foot-wetted once, landed briefly, and foot-wetted twice on its return flight. A tern circled through my study area at 1205 (T_A = 37.5°C), foot-wetted twice and drank twice. At 1350 (T_A = 40.4°C) a tern foot-wetted, landed in water at heel depth, and foot-wetted on its flight back to the dry impoundment. A tern foot-wetted and drank on the wing at 1640 (T_A = 43.4°C). At 1734 (T_A = 43.8°C) a tern belly-soaked once and foot-wetted four times as it returned to its presumed nesting site. At 1800 (T_A = 43.7°C) a tern belly-soaked once and flew back toward the presumed nest. At 1900 I went to the place where the terns had consistently flown after each foot-wetting and belly-soaking bout and discovered one stick-

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lined tern nest with 2 eggs. The adults were in the immediate vicinity. The colour patterns on the eggs were obscured by a thin sheet of dried mud and a large clump of dried mud adhered to one egg. This nest was located in the center of a large, nearly dry impoundment. The impoundment may have held more water when nest construction began. This pair of terns had to fly over 400 metres each way to transport water to the eggs during the two days of observation.

On 4 July 1976 I discovered 17 Gull-billed Tern nests with a total of 4 chicks and 33 eggs on a barnacle bar on the shoreline of Salton Sea at Beach Road. Foot-wetting and belly-soaking were observed many times between 1800 and 1930 on this date by Sandra S. Grant and the author. Only nine nests and 13 eggs were present on 13 July 1976 in this colony. I monitored ground in shade temperatures (inside meteorological box), water temperatures (near where soaking occurred, 2.5 cm below the surface), and ground in sun temperatures (shading probe as I placed it on ground surface that had been exposed to full sun) with a Yellow Springs Telethermometer and recorded belly-soaking bouts by the two pairs of Gull-billed Terns close to my blind (Figure 1). Unfortunately 11 pairs of Forster's Terns (*Sterna forsteri*) were nesting between my blind and the two pairs of Gull-billed Terns. This made it difficult to follow individual birds and in some cases species identification was difficult. Foot-wetting often

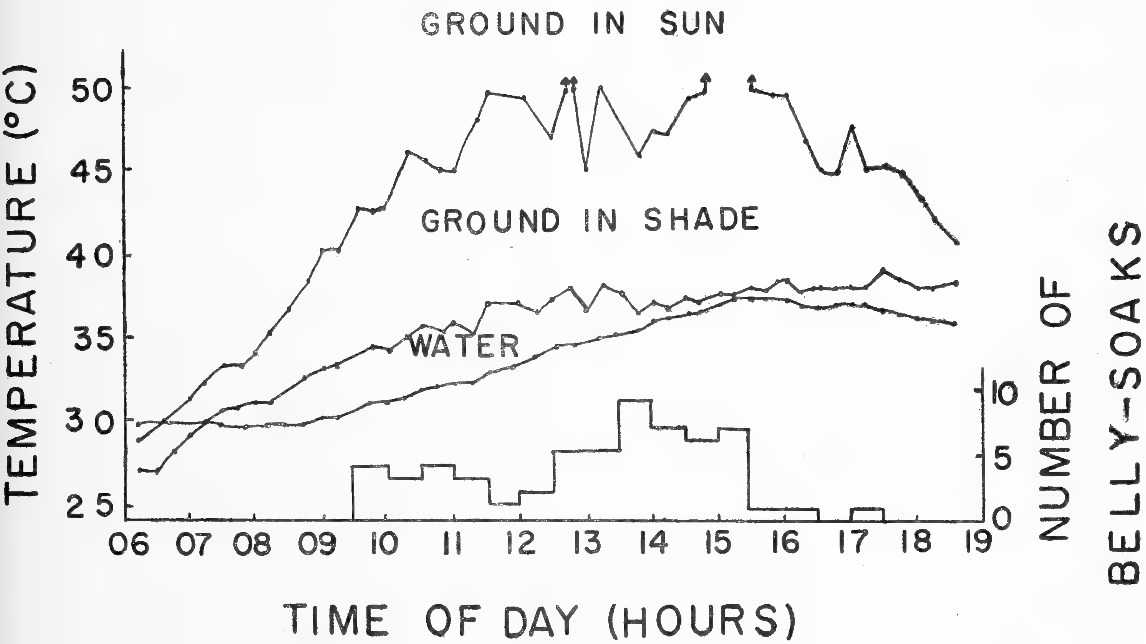

Fig. 1. Environmental temperatures and frequency of belly-soaking by two pairs of Gull-billed Terns at Salton Sea, California, on 13 July 1976. Upward pointing arrows indicate recordings above 50°C, the upper limit of the instrument. See text for details on how temperatures were obtained.

grades into belly-soaking and the two were difficult to distinguish at certain times at my observation distance (75-100 metres). Therefore, only the known episodes of belly-soaking by Gull-billed Terns are presented. At this site, foot-wetting generally occurred in the morning and late afternoon with belly-soaking most frequent during the hotter parts of the day. During the heat of the day a tern occasionally left its nest uncovered, flew out over water, dropped down briefly to wet its belly, and flew directly back to the nest. The nests were only a few metres from the water's edge and one way belly-soaking flights were generally less than 50 metres.

To my knowledge, foot-wetting and belly-soaking have not been previously reported in Gull-billed Terns. Among terns, belly-soaking has been reported in *Sterna fuscata* by Stonehouse *in* Drent (1972), Dinsmore (1972), and T. R. Howell (*pers. comm.*); *S. albifrons* by Abdulali (1939), Ali & Ripley (1969), Dharmakumarsinhji (1964), Hardy (1957), Mabbett (1890), and Tompkins (1942); *S. acuticauda* by Ali & Ripley (1969), Currie (1916), and Lowther (1949), and *S. aurantia* (Lowther 1949).

Black Skimmer.—Foot-wetting was obsered in incubating Black Skimmers at the north end of Salton Sea on 16 and 30 August and 13 September 1975 (Grant & Hogg 1976). In addition, Sandra Grant and I observed belly-soaking in skimmers from 1520 (T_A = 35.0°C) until 1804 on 30 August 1975 at this colony. Jeanne and Norman Hogg, Sandra Grant and I observed and photographed several skimmers belly-soaking on 13 September 1975 (T_A *c.* 32-35°C). Belly-soaking in skimmers is accomplished by holding wings high and allowing the belly to plow through the water. A typical mid-day water transport sequence involved foot-wetting, then belly-soaking, and foot-wetting again as the skimmer pulled away from the water. Drinking frequently occurred during such belly-soaking episodes. A nesting colony of skimmers was found near the above mentioned Beach Road colony of Gull-billed Terns on 4 July 1976. This colony contained 13 nests with a total of 36 eggs on 13 July 1976. Foot-wetting and belly-soaking were observed on both evening visits. I did not approach the nests during the heat of the day on any occasion for fear of heat stressing the eggs and chicks. Foot-wetting and belly-soaking have not been observed in any of the non-nesting terns and skimmers.

Belly-soaking has not been previously described in the Black Skimmer although foot-wetting was discussed by Grant & Hogg (1976). Foot-wetting (Turner & Gerhart 1971) and belly-soaking (Roberts 1976) were observed in incubating African Skimmers (*Rynchops flavirostris*) in response to high temperatures and Ali & Ripley (1969) and Lowther (1949) stated that *Rynchops albicollis* transports water *via* the belly feathers to its eggs and young. Pettingill (1937) described foot-wetting and belly-soaking in Black Skimmers but called it injury feigning behaviour. His (p. 243) description is, "Individuals nesting near this water area feigned injury by swooping down upon it as upon land and dragging their bellies along the surface, or, flying above it, splashing their feet in the water as if walking." Unfortunately, Pettingill did not present any temperature data other than general comments about it being hot on some days. Undisturbed incubating birds at Salton Sea belly-soaked and feet-wetted less frequently than disturbed birds. Human disturbance at temperatures greater than about 32°C on sunny days often induced a flurry of belly-soaking and foot-wetting activities in this skimmer colony. This suggests that belly-

soaking in Black Skimmers may be derived from a distraction display (injury feigning) rather than bathing. More study is needed to clarify the origin of belly-soaking, as pointed out by Maclean (1975).

Conclusions

Foot-wetting and belly-soaking consist of acquiring and transporting water *via* the feet, legs, and ventral plumage to the eggs and chicks, possibly for 1) cooling the incubating bird exposed to intense solar radiation, 2) supplementing water intake of the chicks (Cade & Maclean 1967), 3) cooling the eggs and chicks, 4) increasing nest air humidity, or 5) some or all of the above. Belly-soaking has been reported in Pteroclidae, Charadriidae, Glareolidae, Recurvirostridae, Laridae, Sternidae, Rynchopidae (Maclean 1975), and Pandionidae (Nickell 1967). Opportunistic utilization of standing water at a leaking tap by *Vanellus malabaricus* for cooling the adults and eggs during the hotter part of the day has been well described by Jayakar & Spurway (1965a, 1965b). Investigations are currently underway for monitoring egg temperature and nest humidity in other belly-soaking Charadriiformes at Salton Sea. It was not possible to monitor egg temperatures of Gull-billed Terns and Black Skimmers because of their extremely small breeding populations in the western half of the United States.

Acknowledgements

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NEW DESCRIPTIONS

A NEW SPECIES OF *POLYSTICHUM* FROM SHILLONG (MEGHALA

N. C. NAIR[2] AND KALPANA NAG[3]

(*With eight text-figures*)

While examining the *Polystichum* sheets of the aculeatum group present in Central National Herbarium, Sibpur and the various herbaria of the circles of the Botanical Survey of India it was discovered that a specimen from Shillong area (Meghalaya) appears very unlike any other member of the group. It is closely allied to *P. setiferum*, but is distinct in having 3 types of scales on the rhizome and base of stipe, adpressed scattered scales on the upper region of stipe and rachis, and 3 types of scales on the rachis. The pinnules are also very different. The plant was previously identified as *P. lobatum* (Huds) Pr. var. 4.

Polystichum heteropaleaceum sp. nov. (Figs. 1-8).

Polysticho setifero (Forsk.) Moore ex Woynar affine, sed squamis trium dissimilium formarum in rhizomate, stipitum basibus, rachidibusque, squamis adpressis dispersis sursum in stipitibus rachidibusque differt.

Rhizome erect to suberect, closely scaly; scales of three kinds namely 1. linear shiny reddish brown, fibrillose scales up to 3 cm long and up to 1 mm broad and with ciliate margin (Fig. 3). 2. Ovate to lanceolate scales up to 3.5 cm long and up to 4 mm broad with acute or acuminate tip and having ebonaceous thick median region and pale or hyaline margin which is irregularly ciliated towards the base and entire towards the apex (Fig. 4). 3. linear lanceolate scales up to 1 cm long and up to 0.5 mm broad with highly ciliate margin; cilia 2-to 3-fid at the tip (Fig. 5). Stipe up to 20 cm long grooved, basal region closely covered with scales similar to those of the rhizome, upper region stramineous with sparse ovate brownish scales and adpressed blackish scales. Rachis densely scaly with 3 types of brown scales such as pale coloured linear lanceolate scales (Fig. 6), broad ovate acuminate scales (Fig. 7) and linear ovate scales (Fig. 8); all scales strongly acuminate with ciliate margin. Lamina up to 62 cm long; 10 cm broad, lanceolate acuminate, broadest in the middle, bipinnate, coriaceous, pinnae acuminate, 1.2 cm broad, midrib grooved, raised on the lower surface, basal region covered with fibrillar brown scales. Pinnules subsessile to sessile, up to 0.7 cm long, 0.2—0.3 cm broad, auricled on the acroscopic side, cuneate on the basiscopic side, few scales present on the basal part of the costa; basal pinnule 2-4-lobed, auricle rounded or aristate, apical lobes always aristate; other pinnules 2-lobed and 4-5 aristate towards apex. Sori

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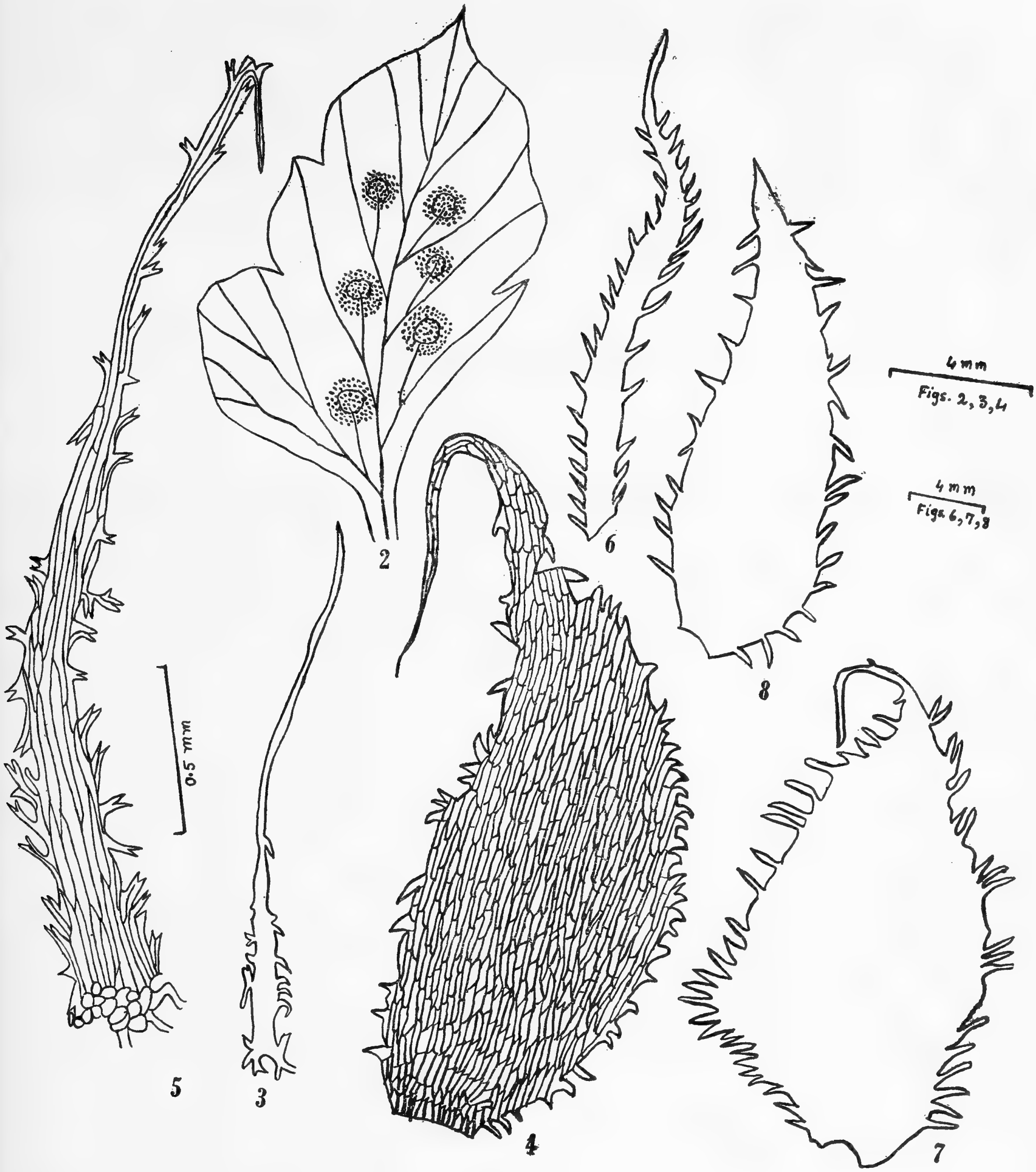
Fig. 1. Type of *Polystichum heteropaleaceum* sp. nov.



Polystichum heteropaleaceum sp. nov.
Fig. 2. Basal pinnule. Figs. 3-5. Rhizome scales. Figs. 6-8. Outline of scales of rachis.

uniseriate on either side of the costa, quite away from the margin, 2-6 per pinnule. Indusium small, peltate not covering the entire sorus, margin crenate, caducous. Spores monolete.

Type: Peak forest, Khasia & Jaintia hills, Shillong, *G. K. Deka* 3960, 22.12.1957, (Acc. No. 6003, ASSAM); Photograph No. 7 (CAL). Isotype: *G. K. Deka* 3960 (Acc. Nos. 6005, 28770, ASSAM). This fern is abundant in the type locality.

We are thankful to Dr. N. C. Mazumdar, Central National Herbarium, Sibpur, for the latin translation and thanks are also due to the Deputy Director, Botanical Survey of India, Eastern Circle, Shillong for kindly sending the specimens for our study.

A NEW VARIETY OF *WENDLANDIA SCABRA* KURZ FROM BURMA (RUBIACEAE)[1]

M. P. NAYAR AND K. C. MALLICK[2]

Wendlandia scabra Kurz var. **tenasserimensis** var. nov.

A typo differt, calyx tubo glabro vel perminute setoso, corollae tubo gracili longiore.

Frutex striatus, ramuli tereti, juniores tomentosi, subangulari. *Folia* opposita, 4-15 x 1.7-5.5 cm, elliptica ad elliptico-obovata, ad basin cuneata, margine integra, ad apicem abrupte acuminata, in utraqua pagina adpresse setosa, costa nervisque brevi-pubescentibus exceptis; nervia lateralibus 8-10 jugis; Folia petiolo 1.5-2.5 cm longo pubescento praedita. Stipulae interpetiolares ad basin ovato-triangulares, ad apicem foliaceae emarginatae late rotundo-suborbicularesque. *Inflorescentiae* terminales, corymbosae vel paniculae, 12 cm longae, 12 cm latae; Flores albi, parvi 3.5-4 mm longi, pedicellati, bracteae anguste lanceolatae ad ligulatae, 2-10 mm longae, pubescentes; bracteolae lineares 0.5-1.25 mm longae, pubescentes. *Calyx* 0.6 mm longus; calycis dentes 0.6 mm longi, triangulares, ciliati; calyx tubo glabro vel perminute setoso. *Corolla* tubulosa vel salviformis 2.5-3 mm longa, glabra, 5-lobata, raro 4-lobata; lobis triangularibus ad apicem acutis, vel recurvis; *Stamina* 5, raro 4, interlobos corollae inserta; filamentis 0.25 mm longis; Antherae ovoideo-oblongae, 0.75 mm longae, 0.5 mm latae, versatiles. Ovarium 0.5 mm longum 2-loculare; ovula in loculis numerosa. Stylus 3-3.5 mm longus, glaber; stigmate 2-lobo, lobis oblanceolatis praedito.

Holotypus (*Gallatly* 496A) et isotypi (*Gallatly* 496B-E) lecti die 27.3.1877 ad Youngzalun, Tenasserim in regione Burma; Holotypus et isotypi positi CAL.

A shrub with striate, rounded branches, young branchlets subangular, covered with tomentum. *Leaves* opposite, 4-15 × 1.7-5.5 cm elliptic to elliptic-obovate, base cuneate, margins entire, apex abruptly acuminate, minutely appressed setose-hairy both surfaces except the nerves which are short pubescent, lateral nerves 8-10 pairs; petiole pubescent, 1.5-2.5 cm long; stipules interpetiolar with ovate triangular base and broadly rounded suborbicular shallowly emarginate tip. *Inflorescences* terminal, corymbose, upto 12 cm long and 12 cm

[1] Accepted January 1977.

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broad, bracts narrowly lanceolate to ligulate 2-10 mm long, pubescent, bracteoles linear 0.5-1.25 mm long, pubescent. *Flowers* 3.5-4 mm long; white, in clusters of 3-4, sometimes 5, pedicels short, less than 0.5 mm long, thinly pubescent. Calyx 0.6 mm long, tube connate with the ovary, glabrous or with few minute setose hairs; teeth as long as the receptacle, 0.6 mm long, triangular, ciliate; corolla salver-form 2.5-3 mm long, glabrous, 5-lobed, rarely 4-lobed, lobes triangular, apex acute, recurved, 1-1.5 mm across the mouth of the corolla. *Stamens* 5, rarely 4, filaments short 0.25 mm long, arising from between the corolla-lobes; anthers ovoid-oblong, 0.75 mm long and 0.5 mm broad, versatile. Ovary 0.5 mm long, 2-loculed with many ovules in each cell; style 3-3.5 mm long, glabrous; stigma bifid, lobes oblanceolate.

This variety differs from the typical species in having usually glabrous or rarely minutely setose calyxtube and slender longer corolla-tube.

Burma: Youngzalun river, Tenasserim, 27.3.1877, *Gallatly* 496A—holotype, B-E-isotypes (CAL).

NOTES ON SOME ORCHIDS FROM BHUTAN[1]

N. P. Balakrishnan

(*With four text figures*)

During the course of studies on orchids of Bhutan, one new species (*Pomatocalpa bhutanicum*) and two new varieties (*Bulbophyllum odoratissimum* Lindl. var. *racemosum* and *Coelogyne occultata* Hook. f. var. *uniflora*) were discovered and are described and illustrated. A rare species (*Chierostylis bhotanensis* Tang & Wang) is also described with illustrations.

Bulbophyllum odoratissimum Lindl. var. **racemosum** var. nov. (Fig. 1).

Differt a var. *odoratissimo* inflorescentiis foliis longioribus, 12-15 cm longis; pedicellis cum ovariis longioribus, ± 1 cm longis; floribus laxiracemosis, magnis, ± 2 cm latis, inodoris, omnino albis.

Epiphyte; rhizome woody, long-creeping, ± 2 mm thick, brown; pseudobulbs placed at 3-4 cm apart, oblong, subcylindric, fusiform, ± 2 cm long, ± 1 cm thick, smooth, glossy, yellowish-green. *Leaves* subsessile or sessile on pseudobulbs, elliptic-oblong, subacute to slightly notched at apex, narrowed at base, 5-7 cm long, 1.3-11.7 cm broad, glossy above, pale beneath, coriaceous, 1-nerved. *Inflorescence* arising from the base of pseudobulb, 12-15 cm long, much longer than leaves; peduncle green, covered with 5-6 tubular acute sheaths. *Flowers* 15-20, laxly racemose, white, ± 2 cm across; floral bracts ovate-lanceolate, concave, acute, ± 7 mm long, ± 2 mm broad, green; pedicel with ovary ± 1 cm long, 1.0-1.5 cm thick, white, greenish at base, patent. *Sepals* linear-lanceolate, falcate, broad at base, terete, blunt at apex, 9-10 mm long, 2.0-2.5 mm broad at base. *Petals* ovate, acute, ± 2 mm long, ± 1 mm broad. *Lip* attached to the apex of foot, mobile, ovate to lanceolate, acute, ± 2 mm long, ± 1 mm broad, fleshy, minutely tuberculate on upper surface, grooved in middle. *Column* ± 2 mm long, ± 1 mm

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broad, bimucronate at apex, slightly winged below; operculum 3-lobed, $\pm$ 0.5 mm broad, papillose on midlobe. *Pollinia* 4, the two lateral ones larger and the two inner ones smaller.

Specimens: Tashiyangtsi, E. Bhutan, 1800 m, 24 Oct. 1965 (in veg. condition), flowered at National Orchidarium, Shillong, Meghalaya State in Pot No. 3614, *Balakrishnan* 43070 A (Holotypus in CAL), *ibid*. 43070 B-D (Isotypi in ASSAM).

This differs from the type var. *odoratissimum* in inflorescences being longer than

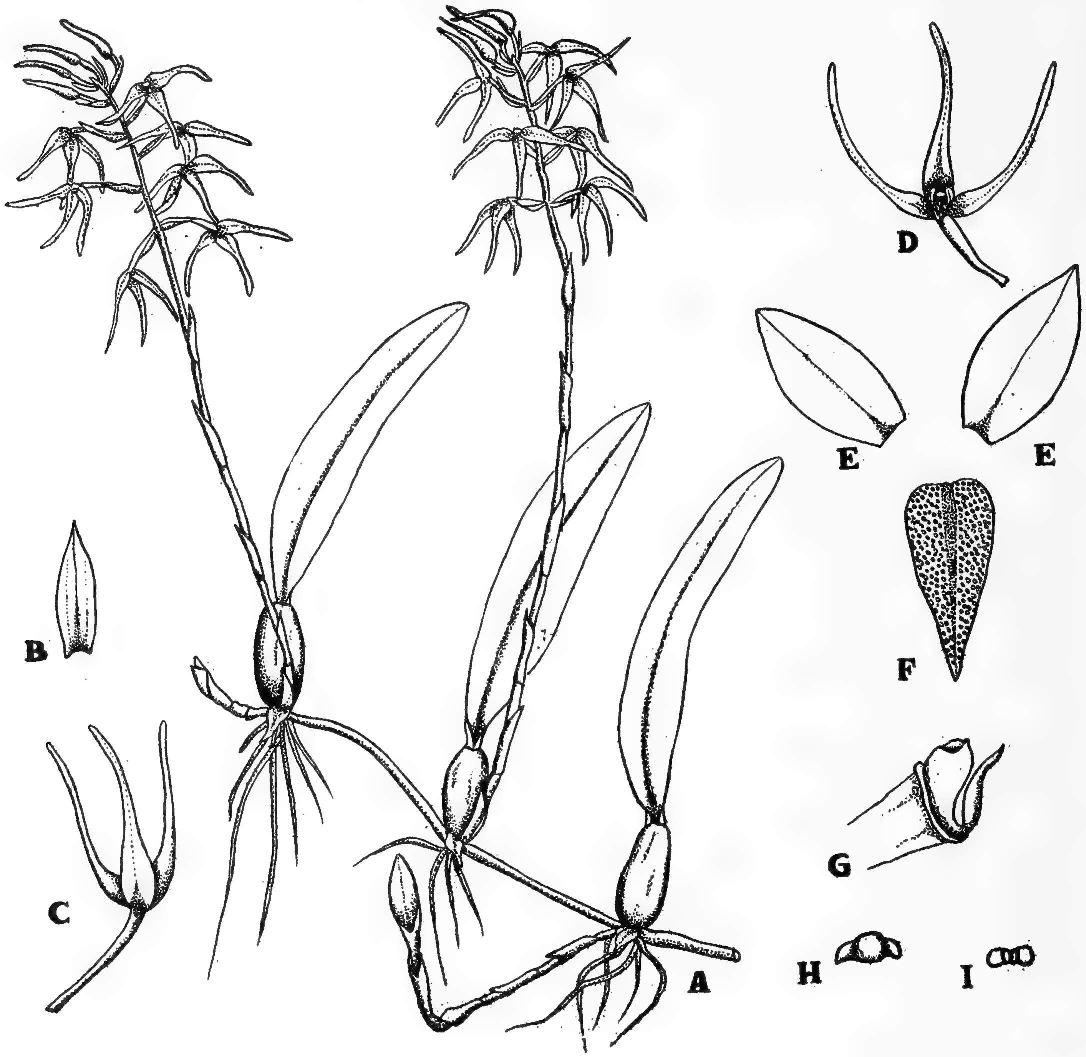


Fig. 1. *Bullophyllum odoratissimum* Lindl. var. *racemosus* Balakr. A. plant, *c*. $\times \frac{1}{4}$; B. bract, *c*. $\times \frac{1}{2}$; C. flower, *c*. $\times \frac{1}{2}$; D. flower, inner view, *c*. $\times \frac{1}{2}$; E. petals, *c*. $\times$ 5; F. lip, *c*. $\times$ 5; G. column, *c*. $\times$ 5; H. operculum, *c*. $\times$ 5; I. pollinia, *c*. $\times$ 5.

leaves, 12-15 cm long; pedicels with ovaries longer, ± 1 cm long and flowers laxly racemose, larger, ± 2 cm across, inodorous, entirely white.

Cheirostylis bhotanensis Tang & Wang in Acta Phytotax. Sin. 1:86. 1951 (Fig. 2).

Terrestrial or lithophytic herb; stem decumbent-ascending, moniliform, rooting at nodes, 5-10 cm long; light pink; internodes 5-10 mm long, 4-8 mm thick. *Leaves* more or less crowded, ovate, cordate, acute at apex, 1.2-2.3 cm long, 1.0-1.5 cm broad, greenish-red, pale pink when dry; main nerves 3, distinct with 2 intramarginal faint nerves; secondary nerves transversely reticulate; petiole ± 2 mm long; sheaths tubular, ± 3 mm long. *Peduncles* terminal, erect, 6-12 cm long, pubescent; bracts 4, distantly placed, ovate, acuminate, stiff-pointed at apex, tubular, clasping at base, 3-9 mm long, glabrous; rachis 3-12 mm long, hairy. *Flowers* 4-8 per rachis, white, 11-13 mm long, 7-8 mm across, placed at intervals of 1.5-2.0 mm apart, subcorymbose; floral bracts equal to ovary, ovate, acuminate, incurved and clasping the ovary, stiff pointed at apex, 5-8 mm long, 2-4 mm wide; greenish brown; pedicels with ovary 5-7 mm long, glabrous, green. *Calyx* ± 5 mm long, connate up to middle, pinkish, glabrous; tube 2-3 mm long, gibbous at base; lobes 3, 1-nerved; dorsal lobe obtuse at apex; lateral lobes acute at apex. *Petals* free, obovate, obtrullate-subfalcate, obtuse, ± 5 mm long, ± 1.5 mm wide, white with pink tinge, included within calyx. *Lip* 8-10 mm long; basal claw boat-shaped, saccate, ± 2 mm long, attached to column and included within calyx, 3-nerved; lateral nerves flabellate-ridged, with rows of fleshy subulate lobes; limb 6-8 mm across, semicircular, with 2 green spots at base, deeply cleft into 2 major lobes; each lobe digitately 5-lobed. *Column* short, fleshy, ± 2 mm long, greenish brown with 2 erect ± 1 mm long white subulate processes; arms of rostellum 2, erect, equal to columnar processes; operculum ovate, ± 1.5 mm long, white tinged with red. *Pollinia* 2, granular, connected to basal linear gland by a common caudicle.

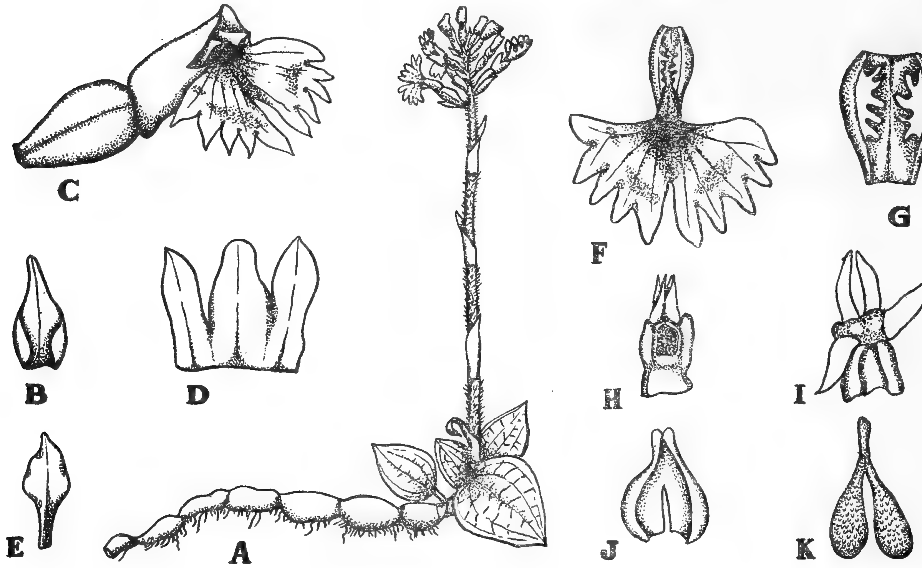
Specimens: Bhotan, *Griffith* 679 (Type in K); Nangardzong, south of Tashiyangtsi, 1500 m, 23 Mar. 1965, *Balakrishnan* 41835 (ASSAM).

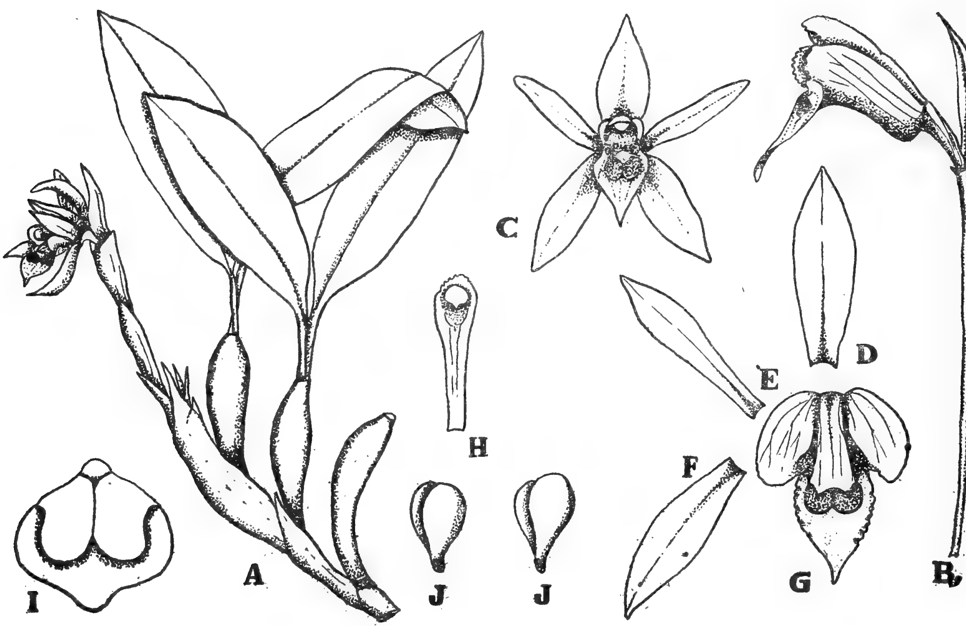
J. D. Hooker (in Fl. Brit. Ind. *6;* 106. 1890) gives the distribution of *C. flabellata* Wt. as Bhutan Himalaya (based on specimens of Griffith), Tenasserim in Burma, Concan and Nilgiris in peninsular India and Ceylon. The specimens of Griffith from Bhutan have been later described as a new species, *C. bhotanensis* by Tang & Wang (1c.). The present collection by me is the first since the type collection almost a century ago. The above description is based on fresh material and agrees closely with the description of Tang & Wang, except for the larger leaves, sepals and lip. The detailed description and illustrations would help in the identification of the species in field and herbarium.

Coelogyne occultata Hook. f. var. **uniflora** var. nov. (Fig. 3).

Differt a var. *occultata* pseudobulbis longioribus linearis oblanceolatis, clavatis ad apices; foliis angustioribus; floribus singularibus, parvioribus; sepalis dorsalibus angustioribus.

Epiphyte; rhizome creeping-elongate, ± 4 mm thick, covered with imbricating scarious sheaths; pseudobulbs oblanceolate, clavate, acute at apex, narrowed to base, 3-4 cm long, 8-12 mm thick, green, glossy, faintly grooved, obliquely attached to the rhizome at intervals of 1-2 cm. *Leaves* paired at apex of pseudobulbs, narrowly elliptic, narrowed at base, acute at apex, 6-7 cm long, 1.5-2.0 cm broad with 3-5 main nerves; petiole grooved above,





Above: Fig. 2. *Cheirostylis bhotanensis* Tang & Wang. A. plant, *c.* $\times\frac{1}{4}$; B. bract, *c.* $\times 1$; C. flower, *c.* $\times 1\frac{1}{2}$; D. calyx, *c.* $\times 1\frac{1}{2}$; E. petal, *c.* $\times 1\frac{1}{2}$; F. lip, *c.* $\times 1\frac{1}{2}$; G. claw of lip, *c.* $\times 3\frac{1}{2}$; H. column, *c.* $\times 3$; I. column with arms of rostellum spread out, *c.* $\times 4$; J. operculum, *c.* $\times 4$; K. pollinia, *c.* $\times 5$.

Below: Fig. 3. *Coelogyne occultata* Hook. f. var. *uniflora* Balakr. A. plant, *c.* $\times\frac{1}{4}$; B. flower with peduncle and bract and without sepals and petals, *c.* $\times\frac{1}{2}$; C. flower, front view, *c.* $\times\frac{1}{2}$; D. dorsal sepal, *c.* $\times\frac{1}{2}$; E. petal, *c.* $\times\frac{1}{2}$; F. lateral sepal, *c.* $\times\frac{1}{2}$; G. lip, *c.* $\times\frac{1}{2}$; H. column, *c.* $\times\frac{1}{2}$; I. operculum *c.* $\times 2\frac{1}{2}$; J. pollinia, *c.* $\times 2\frac{1}{2}$.

1.0-1.5 cm long. *Peduncle* arising from the base of pseudobulb, slender, erect, ± 4 cm long, shorter than leaves, covered almost to the top with wide spathaceous pale green sheaths which enclose at the summit two young leaves. *Flower* solitary, ± 2.5 cm wide, white; floral bracts oblong, acute, ± 2 cm long, ± 1 cm broad, scarious brown; ovary with pedicel green, ± 1 cm long. *Sepals* elliptic-oblong, subacute at apex, ± 2.2 cm long, ± 6 mm broad, spreading, white. *Petals* linear-oblanceolate, subacute, narrowed at base, ± 2 cm long, ± 4 mm broad, white. *Lip* oblong, ± 2 cm long, ± 1.5 cm broad, 3-lobed; lateral lobes large, erect, rounded at apex with crenulate margins in front, white with a dark yellow spot bordered with brownish-red band at the base near the midlobe, also with many brownish-red nerves; midlobe ovate, acute, recurved, hyaline, minutely wavy at margins, white with 2 dark yellow spots bordered with reddish-brown band at base; disc with a long white band bordered on both sides with 2 slender white undulate lamellae extending from base of lip to the base of midlobe and ending abruptly at the two eyes of midlobe, also having a more slender and smaller lamella between the other two. *Column* white with orange yellow band in front at base, broadly winged towards top with crenulate margins at apex, narrow at base, ± 1.4 cm long, ± 4 mm broad at apex. *Pollinia* 4, attached together in pairs to a narrow disc, obovoid.

Specimens: Nyoth Forest, E. Bhutan, 2000 m, 22 Oct. 1965, on moss-covered tree trunk and rock boulders, *Balakrishnan* 43041 A (Holotypus in CAL), ibid. 43041 B-D (Isotypi in ASSAM); Flowered in National Orchidarium, Shillong on 22 April 1966.

This differs from the type var. *occultata* in pseudobulbs being longer, linear, oblanceolate, clavate at apex; narrower leaves, solitary and smaller flowers and narrower dorsal sepals.

Pomatocalpa bhutanicum sp. nov. (Fig. 4).

Affinis *P. ramosa* (Lindl.) Summerh. a qua imprimis differt sepalis quam calcaribus brevioribus; lobiis lateralibus labellorum longioribus, acuminatis; labelli medilobo sagittato, acuto; disco et calcari glabro.

Planta epiphytica; radices effusae, ± 2 mm crassae; caulis elongatus, gracilis, 6-7 cm longus, opertus vaginis foliorum pluribus; internodia brevia. *Folia* effusa, disticha, equitantia, leviter curva, lineari-oblonga, angustata et inaequaliter bilobata ad apices, 10-13 cm longa, 1.0-1.3 cm lata; vaginae internodia quam longiores, tubiformes, obliquae ad ores, manifeste articulatae ad laminas. *Inflorescentia* racemosa e interna vagina siccata exorienti, erecta ad basim, supra patentem; pedunculus teres, semel vel bis ramosus, 8-10 cm longus, uno vel duo vagina scarioso ad basim, viridi-brunneus et purpureo-maculatus; racemi 15-18 floribus; maturescentes centripeti; bracteae late triangulares, acutae, purpureo-virides. *Flores* 4-5 mm diam., non resupinati, calcari directione versus apicem racemi; pedicellus cum ovario ± 5 mm longus, viridis, purpureus ad basim. *Sepala* flavido-viridia, purpureo-maculatis; sepalum dorsale erectum, concavum, incurvatum, oblongum, obtusum, ± 3 mm longum, ± 1.2 mm latum; sepala lateralia concavum, subfalcatum, incurvatum, ovato-oblongum, obtusum, ± 3 mm longum, ± 1.5 mm latum. *Petala* anguste oblonga, obtusa, ± 2 mm longa, ± 1 mm lata, duobus longitudinalibus purpureo-maculatis et viridi-fasciatis ad costas. *Labellum* manifeste trilobatum, calcaratum, carnosum, 6-7 mm longum; lobi laterales incurvi, concavi, triangulares, caudati-acuminati, ± 1.5 mm longi; medilobus triangulariter hastatus, acutus, ± 2 mm longus, ± 1.5 mm

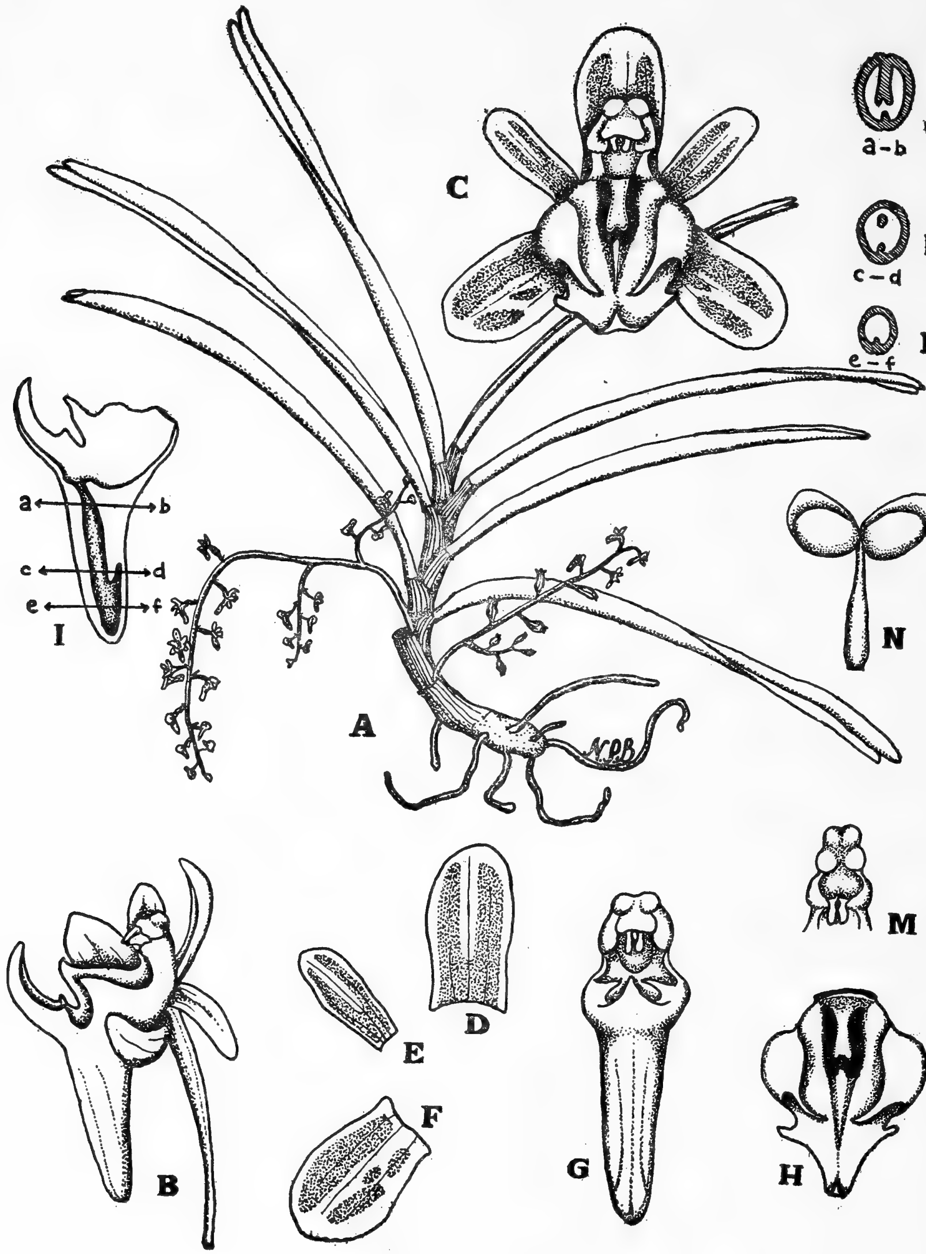


Fig. 4. *Pomatocalpa bhutanicum* Balakr. A. plant, *c.* × 2½; C. flower, top view, *c.* × 4; D. dorsal sepal, *c.* × 4; E. petal, *c.* × 4; F. lateral sepal, *c.* × 4; G. column with lip and spur, front view, *c.* × 2½; H. lip, top view showing mouth of spur, *c.* × 4; I. l.s. of spur, *c.* × 2½; J.K. & L. t.s. of spur at three levels shown in fig. 1., *c.* × 2½; M. column, with operculum lifted up, *c.* × 2½; N. pollinia, *c.* × 7½.

latus, incurvatus ad apicem, longistrorsum leviter sulcatus et biporcatus in disco. *Calcar* compressum laterale et dilatatum ad basim, supra cylindricum et anguste obtusum ad apicem; paries adaxialis verticalis lamellatus, lingulatis, bilobatis ad discretum marginem, fere tegenti calcaris orem; paries abaxialis anguste verticalis porcatus. *Columna* ± 1.5 mm longa; lobi laterales carnosi, adnati ad labellum; rostellum sulcatum, bidentatum; operculum transverse oblongum, subquadrato-rhombicum; pollinia 4, ovoidea, compressa, inaequaliter binata; caudicula spathulata, lata ad basim, angusta ad apicem.

Specimens: Tashiyangtsi, E. Bhutan, 1870 m, flowered in National Orchidarium, Shillong on 24 June 1965, *Balakrishnan* 41993 A (Holotypus in CAL); ibid. *Balakrishnan* 41993 B (Isotypus in ASSAM).

Epiphytic plant; roots spreading, ± 2 mm thick; stem elongate, slender, 6-7 cm long, covered with many leaf sheaths; internodes short. *Leaves* spreading distichous, equitant, slightly curved, linear-oblong, narrowed and unequally bilobed at apex, 10-13 cm long, 1.0-1.3 cm wide; sheaths longer than internodes, tubular, oblique at mouth, distinctly jointed to leaf-blades. *Inflorescence* racemose, arising from behind dry leaf-sheaths, erect at base, patent above; peduncle terete, once or twice branched, 8-10 cm long, with one or two scarious sheaths at base, greenish brown and purple-spotted; racemes 15-18 flowered, maturing centripetally; bracts broadly triangular, acute, purplish-green. *Flowers* 4-5 mm diam., not resupinate with spur directed towards apex of raceme; pedicel with ovary ± 5 mm long, green, purplish at base. *Sepals* yellowish-green, dark purple blotched; dorsal sepal erect, concave, incurved, oblong, obtuse, ± 3 mm long, ± 1.2 mm wide; lateral sepals concave, subfalcate, incurved, ovate-oblong, obtuse, ± 3 mm long, ± 1.5 mm wide. *Petals* narrowly oblong, obtuse, ± 2 mm long, ± 1 mm wide, with two longitudinal purplish-bloches and green midband. *Lip* distinctly 3-lobed, spurred, fleshy, 6-7 mm long; side lobes incurved, concave, triangular, caudate-acuminate, ± 1.5 mm long; midlobe triangular, hastate, acute, ± 2 mm long, ± 1.5 mm wide, incurved at tip, longitudinally faintly grooved and 2-ridged on disc. *Spur* laterally compressed and dilated at base, cylindric above and narrowly obtuse at apex; adaxial wall vertically lamellate, tongue-shaped, bifid at free margin, almost covering the mouth of spur; abaxial wall narrowly vertically ridged. *Column* ± 1.5 mm long; sidelobes fleshy, adnate to lip; rostellum grooved, bidentate; operculum laterally oblong, subquadrate; pollinia 4, ovoid, compressed, unequally paired; caudicle spathulate, broad at base, narrowed at apex.

This species is closely allied to *P. ramosum* (Lindl.) Summerh. but differs mainly in the sepals being shorter than spur; side lobes of lip longer, acuminate; midlobe of lip sagittate, acute; disc and spur glabrous.

STUDIES ON SOME INDIAN APHELINID PARASITES (HYMENOPTERA: CHALCIDOIDEA)[1]

S. IRFAN AHMED AND S. ADAM SHAFEE[2]

(*With twenty-one text-figures*)

An account is given of five Indian species of the family Aphelinidae belonging to the genera *Physcus* Howard, *Coccophagus* Westwood and *Aneristus* Howard. *Physcus gunturensis* sp. n. has been described in detail. Material has been deposited in the Zoological Museum, Aligarh Muslim University, Aligarh.

Physcus gunturensis sp. nov. (figs. 1-9)

FEMALE:

Head (fig. 1):— Yellowish brown, wider than long in facial view (0.34:0.26 mm.); frontovertex slightly more than one and a half times wider than long; ocelli arranged in obtuse triangle, basal ocellus separated by its diameter from eye rim and about twice its diameter from occipital margin; malar space slightly longer than eyes width (0.1:0.09 mm.); malar sutures distinct; mandibles with apical acute tooth and a lower broad truncation; maxillary and labial palpi 2 and 1-segmented respectively.

Antennae (fig. 2):— Orange yellow except radicle, basal three-fourths of scape and first funicle segment are dark brown; scape three and a half times longer than wide; pedicel slightly shorter than first funicle segment; funicle segments third and fourth slightly more than one and a half times longer than wide; club slightly more than three times longer than wide.

Thorax:— Dark brown; pronotum with anterior margin deeply concave in middle (fig. 3); scutum profusely setose; axilla and parapside each with single seta; scutellum longitudinally reticulate bearing three pairs of setae (fig. 4).

Fore wings:— Hyaline, two and a half times longer than wide; costal cell broad; submarginal vein with 11 setae and 18 bullae; stigmal vein one-fourth the length of marginal vein; postmarginal vein slightly developed (fig. 5).

Hind wings:— Hyaline, four and a half times longer than wide; marginal fringe one-half of wing width.

Legs.— Orange yellow; middle tibial spur as long as basitarsus (fig. 6).

Abdomen:— Brownish, longer than thorax; subgenital plate of uniform width, central notch of posterior margin followed by laterally directed ridges (fig. 7); ovipositor concealed, second valvifer of uniform width with a mid longitudinal ridge; third valvulae movably articulated with second valvifers (fig. 8).

Female length: 0.97 mm.

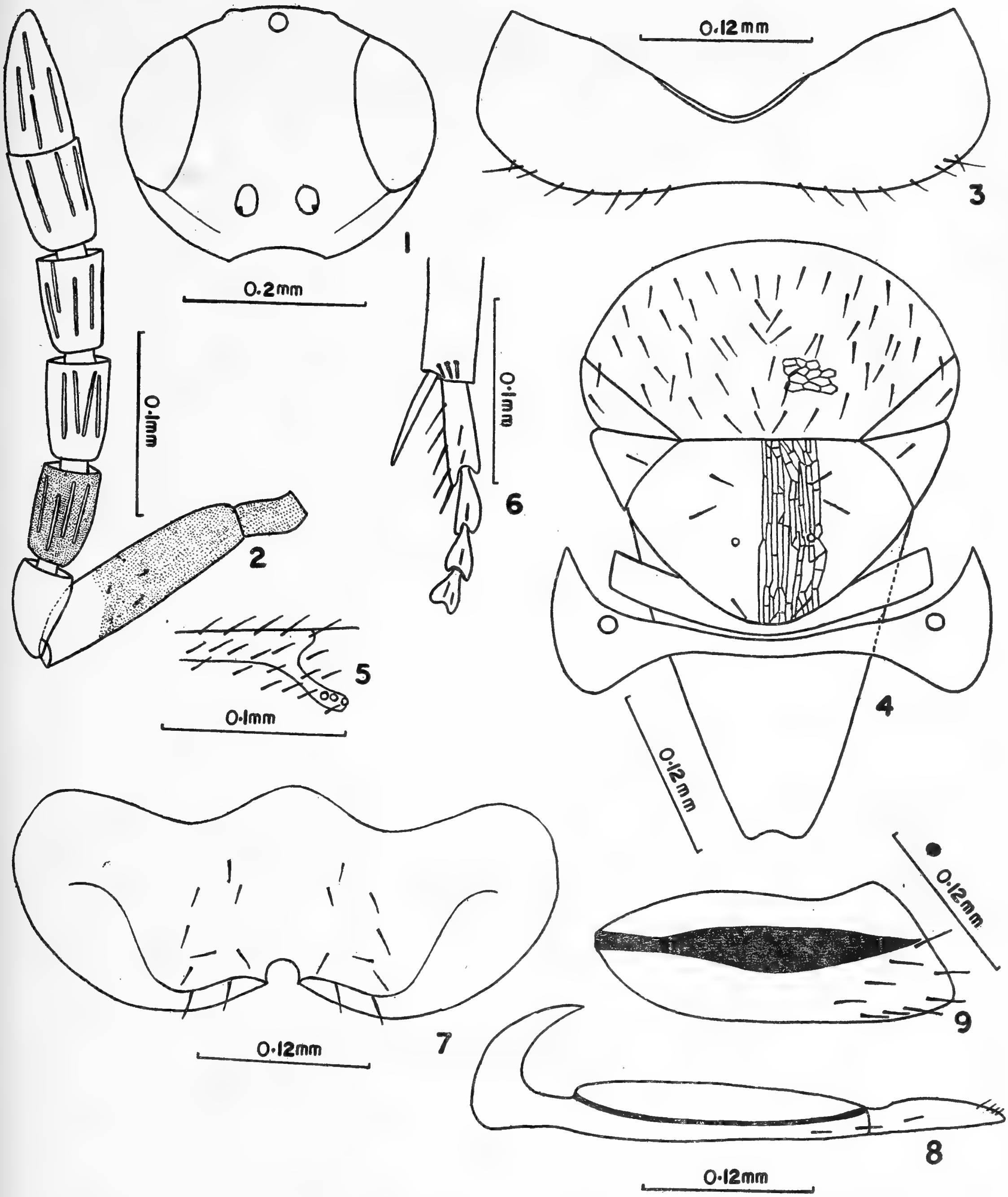
Holotype ♀, INDIA, Andhra Pradesh, Guntur, ex *Aonidielle orientalis* (Newstead), 10.ii.1971 (S. Adam Shafee).

Paratypes 4 ♀, (Same date as for holotype).

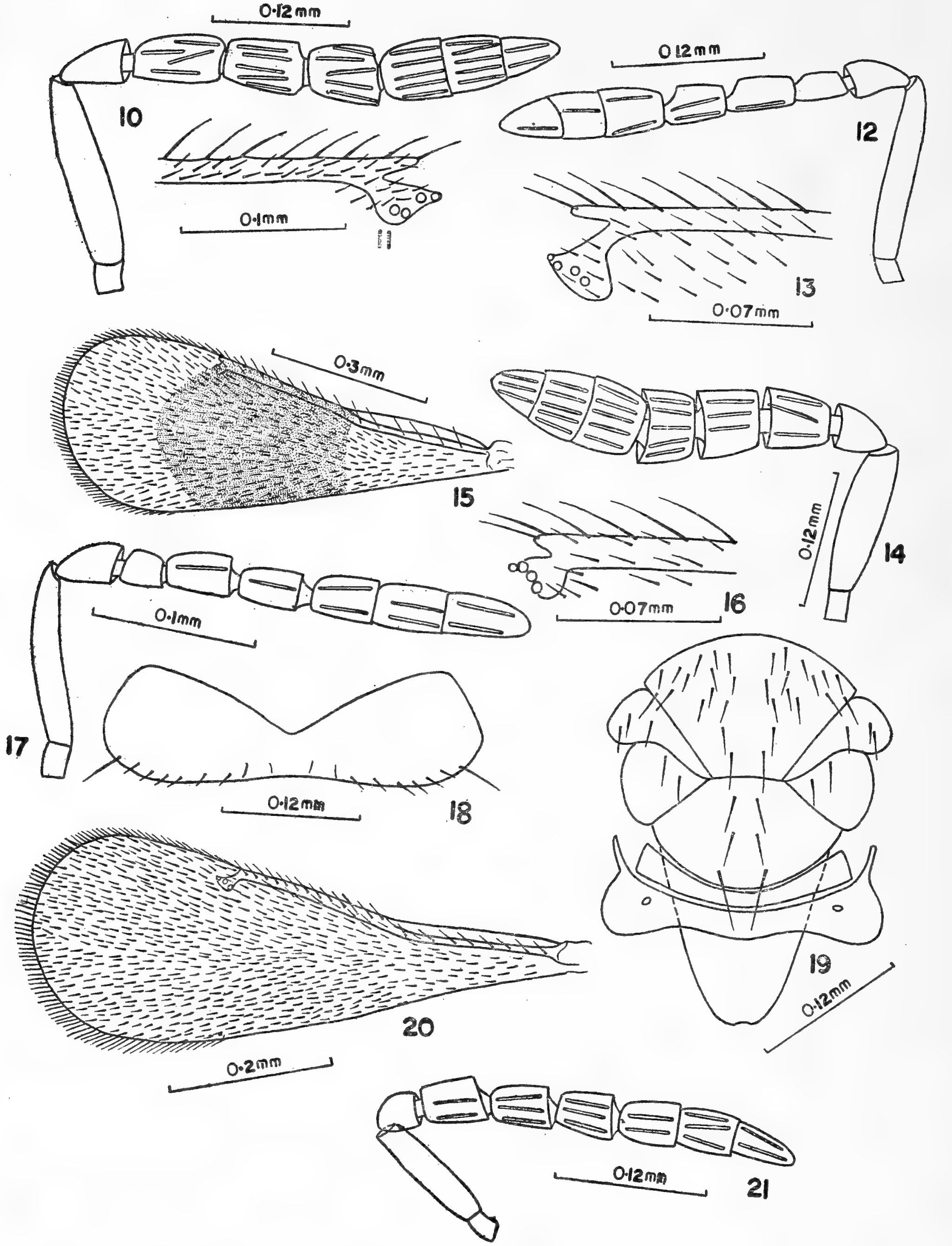
This species is closely related to *Physcus reticulatus* Compere & Annecke, but the two can be differentiated as follows:

[1] Accepted May 1977.

[2] Section of Entomology, Department of Zoology, Aligarh Muslim University, Aligarh, India.



Figs. 1-9. *Physcus gunturensis* sp. nov. ♀: (1) Head; (2) Antenna; (3) Pronotum; (4) Thorax; (5) Part of fore wing venation; (6) Part of middle leg; (7) Subgenital plate; (8) Second valvifer; (9) Outer plate of genitalia.



Figs. 10, 11. *Coccophagus cowperi* Girault, ♀; (10) Antenna; (11) Part of fore wing venation.
Figs. 12, 13. *Coccophagus bivittatus* Compete, ♀: (12) Antenna; (13) Part of fore wing venation.
Figs. 14-16. *Aneristus ceroplastae* Howard, ♀: (14) Antenna; (15) Fore wing; (16) Part of fore wing venation.
Figs. 17-21. *Coccophagus longiclavatus* Shafee, ♂, ♀: (17) Antenna, ♀; (18) Pronotum, ♀; (19) Thorax, ♀; (20) Fore wing, ♀; (21) Antenna, ♂.

P. reticulatus Compere & Annecke
- Scape white, five times longer than wide.
- Pedicel as long as first funicle segment.
- Club almost as long as funicle.
- Abdomen yellow.

P. gunturensis sp. n.
- Scape dark brown in basal three-fourth, three and a half times longer than wide.
- Pedicel shorter than first funicle segment.
- Club distinctly shorter than funicle.
- Abdomen brownish.

Coccophagus cowperi Girault (figs. 10, 11)

Coccophagus cowperi Girault; Compere, 1931, *Proc. U.S. natn. Mus.*, 78:57.

Material examined.— 25 ♀, 8 ♂, INDIA, Andhra Pradesh, Nellore, Bucchireddipalam, ex *Ceroplastodes cajani* (Maskell) on *Psidium guajava* Linn., 27.ii.1968; 9 ♀, ex *Saissetia coffeae* Walker.

Coccophagus bivittatus Compere (figs. 12, 13)

Coccophagus bivittatus Compere, 1931, *Proc. U.S. natn. Mus.*, 78:73-74.

Material examined.— 4 ♀, INDIA, Tamil Nadu, Tenaksi, ex *Coccus* sp. on *Psidium guajava* Linn., 5.iii.1967 (S. Adam Shafee); 8 ♀, 1 ♂, Uttar Pradesh, Ghaziabad, ex *Anomalococcus crematogasteri* Green, on *Prosopis spicegera* Linn., 5.vii.1970; 2 ♀, Rajasthan, Jaipur, Ramgadh Bundh, ex *Eriococcus lagerstromiae* Kuwana on wild plant.

Coccophagus longiclavatus Shafee (figs. 17-21)

Coccophagus longiclavatus Shafee, 1972, *Bull. Ent.* 13:25.

Material examined.— 2 ♀, INDIA, Utter Pradesh, Aligarh, ex *Coccus* sp. on *Mangifera indica* Linn., (S. Adam Shafee).

Aneristus ceroplastae Howard (figs. 14-16)

Aneristus ceroplastae Howard; Compere, 1936, *Univ. Calif. Publs. Ent.* 6:287-288.

Material examined.— 15 ♀, 5 ♂, INDIA, Utter Pradesh, Aligarh, ex *Coccus* sp. on *Hibiscus rosasinensis,* 8.ix.1969, (S. Adam Shafee).

Acknowledgements

We are indebted to Prof. S. Mashhood Alam, Head, Department of Zoology, Aligarh Muslim University, Aligarh for providing research facilities. Thanks are also due to Prof. Nawab H. Khan for encouragement.

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A NEW MYGALOMORPH SPIDER OF THE GENUS *PHLOGIODES* FROM KHASI-JAINTIA HILLS, INDIA (ARANEAE: THERAPHOSIDAE)[1]

M. BARMAN[2]

(*With a text-figure*)

Phlogiodes satyanus sp. nov.

General—Large, hairy spider; carapace, legs and abdomen brown. Upper spinners long. Total length ♀ 24.00 mm; carapace 12.00 mm long, 9.00 mm wide; abdomen 14.00 mm long, 8.00 mm wide.

This spider lives in silk lined tunnels on the ground near the base of pine trees. They are found during autumn.

Cephalothorax—Longer than wide, in the centre of thoracic region depressed procurved fovea; infront of the fovea the cephalic region is slightly higher. Eyes placed close together, anterior row slightly procurved and almost equidistant, posterior row slightly recurved, posterior medians further from each other and almost contiguous with the median lateral of that side. Posterior medians silvery others dull white; all ringed black. Carapace reddish with a number of radiating brownish lines from the fovea. Carapace clothed with fine shiny yellowish white hairs. Endite large conical apically in the inner end. Posterior sternal sigilla large and away from margin, two pairs prominent; labium and endite reddish brown, labium bears dark spots distally and endite near its base. Legs long and stout, brownish, clothed with long spiny hairs. Leg formula IV. I.III. II, leg I 1.3 times the total body length; carapace length equals to that of patella-tibia plus ½ of metatarsus of leg I. Tarsal scopulae of leg IV divided, protarsal scopulae not divided, protarsal pad on all legs.

Abdomen—Oval, brown, densely clothed with long dark brown and white hairs. Posterior spinners long and four segmented Both pairs of lungs prominent.

Holotype—Female.

Type locality—Cantonment area, Shillong (India). 22-10-1973. coll. S. Bhuyan. The type specimen will be deposited in due course, in the collections of the Zoological Survey of India.

Discussion—This species is closer to *P. robustus* Pocock but differs from it in (1) protarsal scopulae of legs not being divided whereas in *P. robustus* protarsal scopulae of leg II is divided by a broad band of setae, (2) presence of protarsal pad on leg III and (3) tarsal pad of leg IV only being divided.

It does not seem to be female of *P. validus* Pocock, where the male only was described due to (1) variation in the leg formulae, (2) cephalic region being high and not narrow, (3) carapace longer than patella-tibia of leg I and IV.

I am grateful to Dr. B. K. Tikader for confirmation of the identification.

[1] Accepted June 1977.

[2] Lady Keane College, Shillong.

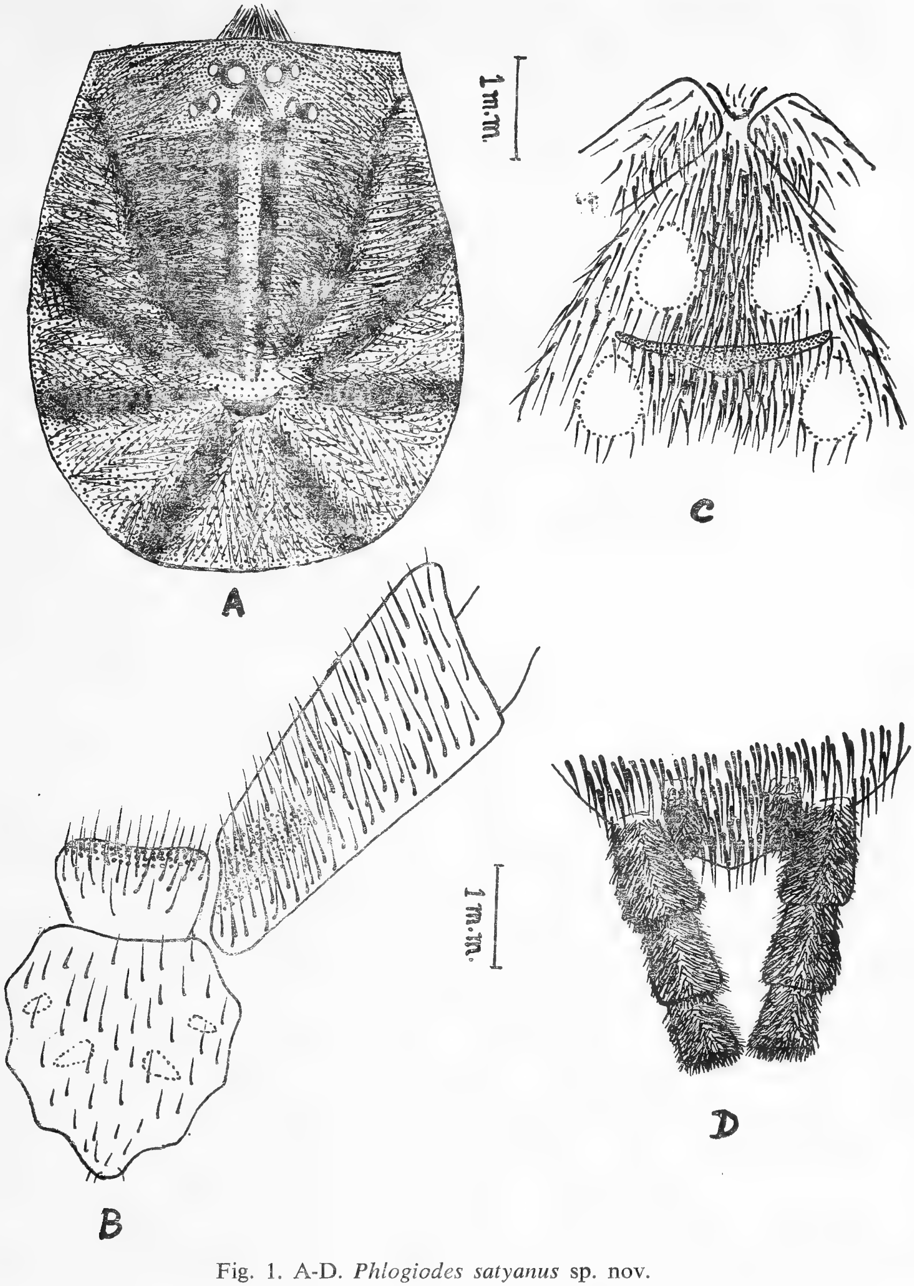


Fig. 1. A-D. *Phlogiodes satyanus* sp. nov.
A. Carapace; B. Sternum with labium and endite; C. Anterior end of abdomen showing lung book; D. Posterior end of abdomen showing spinners.

FURTHER COMMENTS ON THE GENUS *TAMRACA* MOORE WITH THE DESCRIPTION OF A NEW SPECIES FROM CHANDIGARH (LEPIDOPTERA: PYRALIDAE)[1,2]

H. S. Rose and H. R. Pajni[3]

(*With six text-figures*)

Introduction

One hundred and forty five species of Pyralidoidea were collected from North-West India between November, 1972 and November, 1974. Out of these, six species belonged to the sub-family Pyralinae and among these two new species were recognised. One of these along with the up to date characters of the genus *Tamraca* is recorded in the present communication.

Genus *Tamraca* Moore, 1887

Type-species: *Asopia torridalis* Lederer, 1863, *Wien. Ent. Monaschr.* 7: 342, 457, t. 6, f. 15; Moore, 1887, *Lep. Ceylon.* 3:554.

Labial palpus obliquely upturned; third joint porrect; thickly clothed with hair-like scales, reaching well beyond maxillary palpus and the sharp frontal tuft. Maxillary palpus filiform. Proboscis minute. Antenna of male with short fasciculate branches. Tegula of male reaching posterior end of metathorax. Tibiae hairy. Fore wing with costa nearly straight; R_1 free; R_2 free; R_3, R_4 and R_5 stalked; M_2 and M_3 approximated for their one-third length; Cu_1 from distal end of cell. Hind wing with Rs and M_1 stalked; M_2 and M_3 somewhat approximated at base; Cu_1 from near lower angle of cell. Male genitalia with the uncus moderately long and slender; socii present; gnathos well developed, drawn out into a slender process, the latter slightly curved at tip; valva long and simple. Female genitalia without signum in corpus bursae; ductus bursae long and spiral; ovipositor lobes quite broad.

Key to the species of genus *Tamraca* Moore

1. Ground colour of wings dark fuscous, densely suffused with purple; uncus rounded at apex; aedeagus long and uniformly narrow .... *torridalis* Lederer
   Ground colour of wings brown, suffused with fuscous; uncus truncate at apex; aedeagus long and broadened in distal half .... *moorei* sp. nov.

Tamraca moorei sp. nov.

Head: Vertex covered with a tuft of brown scales; frons rounded, with a short and conspicuous frontal tuft. Antenna shorter than the fore wing; scape brown, irrorated with fuscous; flagellum strongly annulated with brown scales, its base deep fuscous, with short and well developed fasciculated branches in male. Eye large, with a row of brown scales behind. Ocellus indistinct. Labial palpus obliquely upturned, with third segment porrect; first segment short, covered with erect brown scales; second segment longer, brown scaled, irrorated with fuscous; third segment furnished with minute scales. Maxillary palpus filiform, clothed with brown and fuscous scales. Proboscis reduced. Posterior margin of head densely adorned with long and erect brown scales.

[1] Accepted January 1978.

[2] From Ph.D. thesis of the senior author, approved for doctrorate degree by the Panjab University, Chandigarh.

[3] Department of Zoology, Panjab University, Chandigarh 160 014.

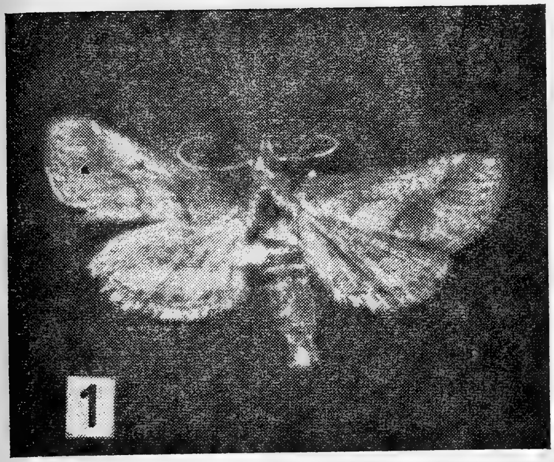
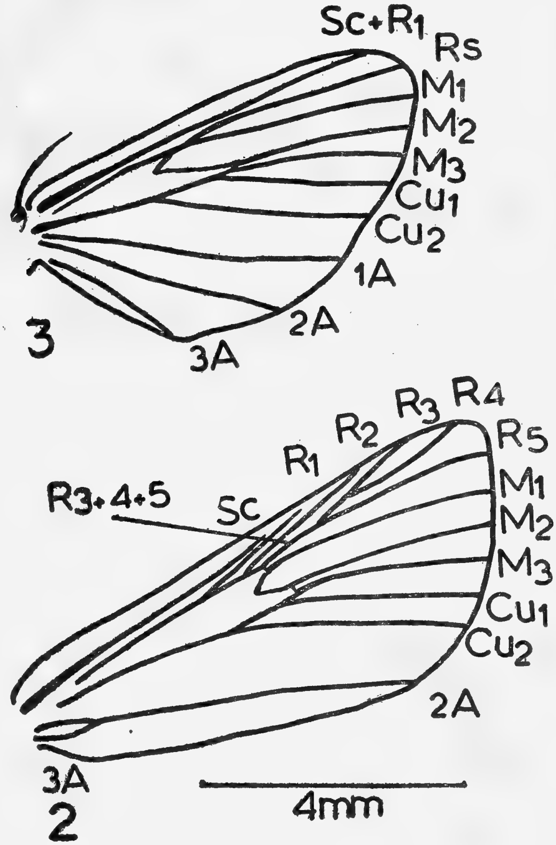


Fig. 1. *Tamraca moorei* sp. nov.
1. The adult.

Thorax: Densely scaled with brown scales on dorsal surface, with scales on tegula slightly longer; under surface of thorax fuscous brown.

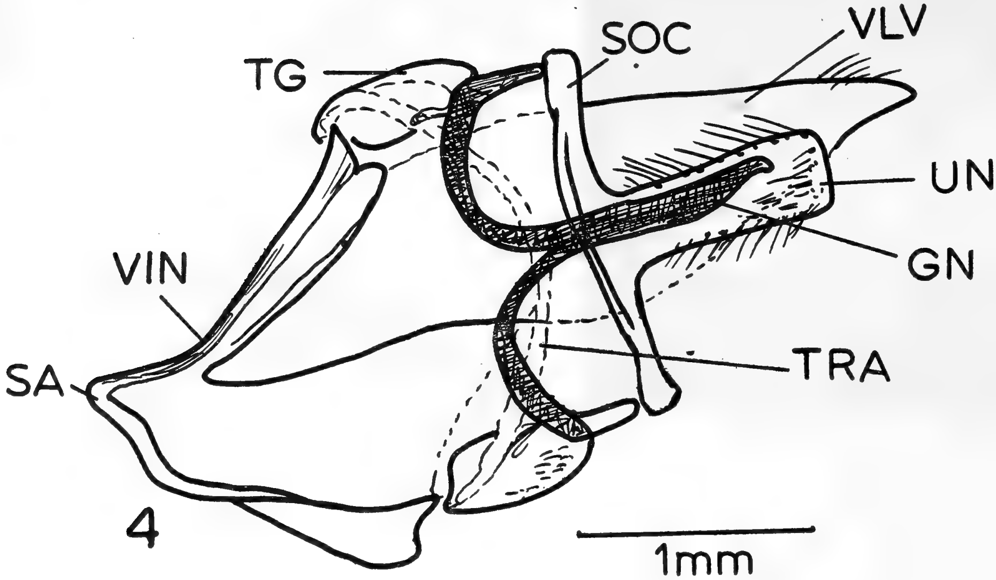
Fore wing: Costal margin straight; apex rounded; termen oblique; tornus rounded; inner margin straight. Ground colour brown; anterior margin irrorated with fuscous and marked with deep fuscous spots; base with greyish tinge, followed by an inwardly running oblique dark line; a poorly defined fuscous discocellular spot; a dark fuscous postmedial line from costa to M_1, obliquely curved inwards and touching anal margin; outer margin with fuscous spots; marginal fringe fuscous grey, with a dark line. Discal cell longer than half the length of wing; discocellulars oblique and straight; cell closed. Sc straight; R_1 free, from well before anterior angle of cell; R_2 free; R_3, R_4 and R_5 stalked; M_1 from base of R_{3+4+5}; M_2 and M_3 from lower angle of cell, approximated at origin for some distance; Cu_1 from distal end of cell; Cu_2 roughly at three-fourth length of cell; 3A making a small anal loop with 2A.

cell half the length of wing; lower angle termen, tornus and inner margin arched. Ground colour light brown, finely irrorated with deep fuscous; outer margin fuscous; marginal fringe brown, with a dark line. Discal cell half the length of wing; lower angle



Figs. 2, 3 .*Tamraca moorei* sp. nov.
2. Fore wing; 3. Hind wing.

Abbreviations: 1A, First anal vein; 2A, second anal vein; 3A, Third anal vein; Cul, First cubital vein; Cu2, Second cubital vein; M1, First median vein; M2, Second median vein; M3, Third median vein; R1, First radial vein; R2, Second radial vein; R3, Third radial vein; R4, Fourth radial vein; R5, Fifth radial vein; R3+4+5, Stalk of R3, R4, R5; Rs, Radial sector; Sc, Subcosta; Sc + R1, Stalk of Sc and R1.



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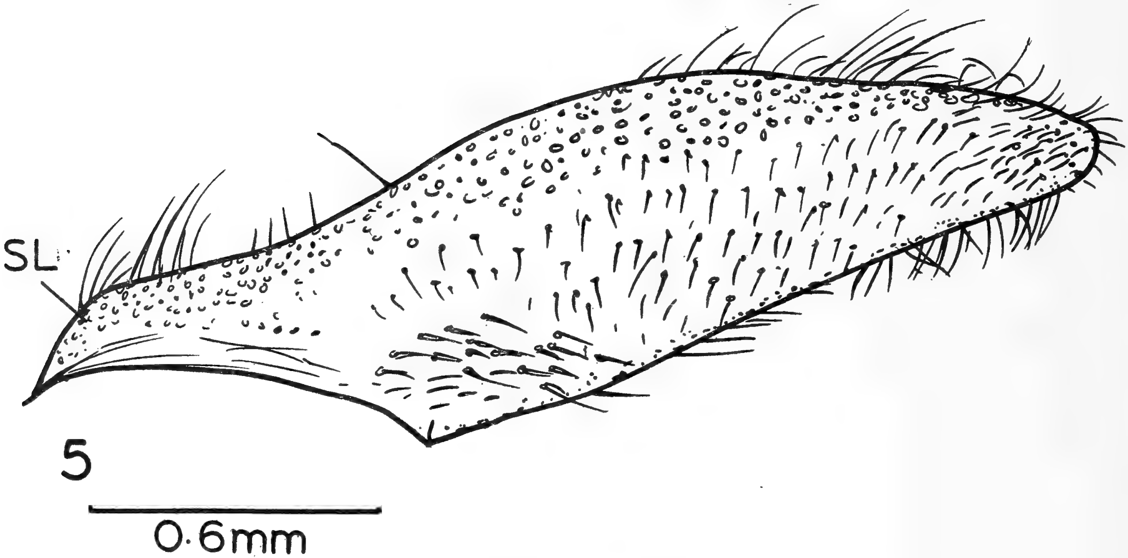

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Figs. 4, 5. *Tamraca moorei* sp. nov.
Parts of the male genitalia.

Abbreviations: SA, Saccus; SL, Sacculus; SOC, Socii; TG, Tegumen; TRA, Transtilla; UN, Uncus; VIN, Vinculum; VLV, Valva.

produced; discocellulars conspicuous; cell closed. Rs apposed to $Sc + R_1$ beyond cell for some distance; Rs and M_1 stalked; M_2 and M_3 from posterior angle of cell, approximately at base, diverging distally; Cu_1 from near angle of cell; Cu_2 from two-third length of cell; three anals present.

Legs: Densely covered with brown scales, irrorated with dark fuscous; tibia prominently scaled, all outer tibial spurs one-third as long as the inner ones.

Abdomen: Brown both dorsally and ventrally, its first segment ringed with fuscous.

Male genitalia: Uncus moderately long and truncate at distal end, lateral sides densely setose with anteriorly directed setae, with apical end naked; socii long and well sclerotized, completely bare; gnathos well developed, shorter than uncus, strongly sclerotized, its arms united in centre and drawn out into a long curved point; tegumen reduced; vinculum more or less V-shaped, produced anteriorly into a reduced saccus. Valva long and simple, with costal margin straight, its saccular margin curved, distal end narrow and rounded; costa not marked; sacculus extremely poorly differentiated at base; harpe absent. Transtilla complete, represented by a transverse strap; juxta more or less oval distally, with a sclerotized line. Aedeagus quite long, narrow anteriorly and broad posteriorly, its wall well sclerotized; vesica without any definite cornutus, adorned with densely packed denticles at distal end.

Female genitalia: Not studied

Alar expanse: Male: 20 mm to 21 mm.

Holotype 1 ♂, 3 ♂♂ paratypes, India, Chandigarh, (U.T.), Sept., 1973. (Collected by H. S. Rose). Material deposited in Entomological Museum, Department of Zoology, Panjab University, Chandigarh-160 014 (India).

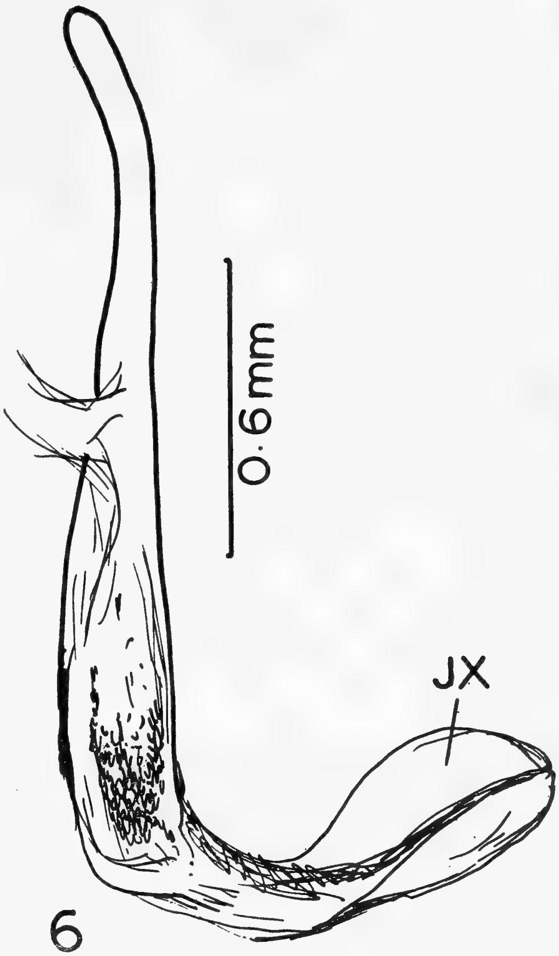


Fig. 6. *Tamraca moorei* sp. nov. Part of the male genitalia.
Abbreviation: JX, Juxta.

ACKNOWLEDGEMENTS

Grateful thanks are due to Dr. G. P. Sharma, Senior Professor and Head, Department of Zoology, Panjab University, Chandigarh for providing research facilities and to Dr. G. S. Arora and Mr. Inderjit Gupta of Zoological Survey of India, 34-Chittaranjan Avenue, Calcutta for their critical suggestions in the preparation of the paper.

ON A NEW SPECIES OF *AGRIOCNEMIS* SELYS, 1869 (COENAGRIIDAE: ODONATA) WITH DESCRIPTION OF ITS LARVA FROM DEHRA DUN VALLEY, INDIA[1]

ARUN KUMAR AND MAHABIR PRASAD[2]

(*With fifteen text-figures*)

INTRODUCTION

Agriocnemis Selys, 1869, is a Oriental genus of Coenagriid damselflies comprising 11 species from the Indian sub-region (Fraser 1933; Sahni 1965). Subsequently Mitra (1975) while reviewing the Indian species of *Agriocnemis* Selys, has doubted the exact identity of *Agriocnemis nainitalensis* Sahni, and suggested inclusion of it in the genus *Ischnura*. Recently, we have been able to breed a new species of this genus, from the larvae collected from a marshy pond at Badripur Vill., Dehra Dun, subsequently 2 more adult females were collected from another marshy perennial pond about 1 km away from type locality at Gorakhpur Village, Dehra Dun. Detailed taxonomic description of the last instar larvae is also given and brief biological notes have been made.

We have pleasure in dedicating this species to Prof. Philip S. Corbet, University of Christchurch, New Zealand, who initiated and constantly encouraged one of us (A.K.) on Odonata biology.

Agriocnemis corbeti sp. nov.
(Figs. 1-7)

ADULT

Male—Holotype: abdomen 19 mm, fore wing 14 mm, hind wing 13 mm. (Emerged in laboratory).

Head: Labrum light cream colour; labium yellow with anterior border black; anteclypeus brownish-yellow; postclypeus dark brown with anterior border black; mandibles light blue. Frons, face and vertex black. Light blue post ocular coloured spot present, a fine line of same colour almost connecting them. Eyes black above and palest blue beneath.

Prothorax: Light reddish brown; posterior lobe reddish; anterior lobe white.

Thorax: (Fig. 1) brownish red on dorsum; mid dorsal carinal suture blood red; antehumeral stripe blue. A blue stripe present on the metepimeron. Ventrally cream yellow. Hooks on the anterior border of thorax absent. Legs white; distal end of femur black dorsally; spines black; 4 spines present on hind pair of tibiae and 7 spines on corresponding femora.

Wings: (Fig. 2) hyaline; pterostigma similar in shape and size in fore and hind wings, covers less than one cell, diamond-shaped, distal side more oblique than proximal; 9 postnodal nervures in fore wings, 7 in hind wings. Discoidal cell acutely pointed at distal end, costal side of discoidal cell is nearly half of the distal end in forewing and three fourth in hind wing; in fore wing basal side is shorter than costal side; in hind wing it is just half, distal side of discoidal cell oblique. Sectors of arc arising from the lower end of arc and divergent from their origin. Arc situated more distal to the distal antenodal nervures. Nervure A B present and arising well proximal to the AC; A B

[1] Accepted December 1977.

[2] Northern Regional Station, Zoological Survey of India, Dehra Dun, India.

continued as nervure 1A with an angulation (medio-anal line) at the junction of the two; nervures RIV+V arising well before the oblique nervure descending from the subnode.

Abdomen: (Figs. 3 & 4) brick-red in colour, marked with black as follows: Apical joints of segment 2-7 ringed with black. A black triangular spot with a deep notch anteriorly present on the first segment. Segment 2 with a broad squared, black dorsal spot constricted abruptly near the apical annule. Segment 3 with a small black triangular spot on its dorsum which is pointed posteriorly. Seventh segment black on dorsum, constricted in middle and then again dilated upto apical joint as illustrated in the diagram; 8th and 9th segment totally black; and 10th with a small rounded basal black spot on dorsum.

Anal appendages: (Fig. 5) pale yellow; superior as long as segment 10th; pale yellow, tipped with black. It is broad at the base and tapering into a small curled spine at the apices; inferior black, less than half the superior and pointed at tip.

Female—Allotype: abdomen 17 mm, forewing 12 mm, hind wing 11.5 mm. Paratype; abdomen 17-18 mm, fore wing 12-15 mm, hind wing 11.5-12 mm.

Head: Labium light yellow; labrum chocolate brown; ante and postclypeus brownish red, with two small rounded white spot on each side of anteclypeus; mandible light brown. Face frons and vesicle black; occiput rose-red. Chocolate brown post occular spot present; a fine line of same colour almost connecting them. Eyes similar to male.

Prothorax: Chocolate brown; lateral side pale yellow; posterior lobe rose-red.

Thorax: Chocolate brown; mid dorsal carina red; antehumeral stripe black; metepimeron yellow; ventral side white. Legs brownish yellow with black spine; distal end of femora black; 4 spines on hind femora of tibiae and 7 on the corresponding femora.

Wings: Similar to male except 7 postnodal nervure in fore wing and 5-6 in hind wing.

Abdomen: (Figs. 6 & 7) brick-red; apical joint ringed with black; 6-10 abdomenal segments black on dorsum with two small reddish spots on lateral sides of 7th & 8th segment. Abdomen ventrally yellow.

Anal appendages: yellow, small in size and conical in shape; vulvar scales yellow.

Material examined:

1♂. Holotype: India, Dehra Dun, Badripur Vill. Em. from larva on 10.3.1976, Coll. A. Kumar.

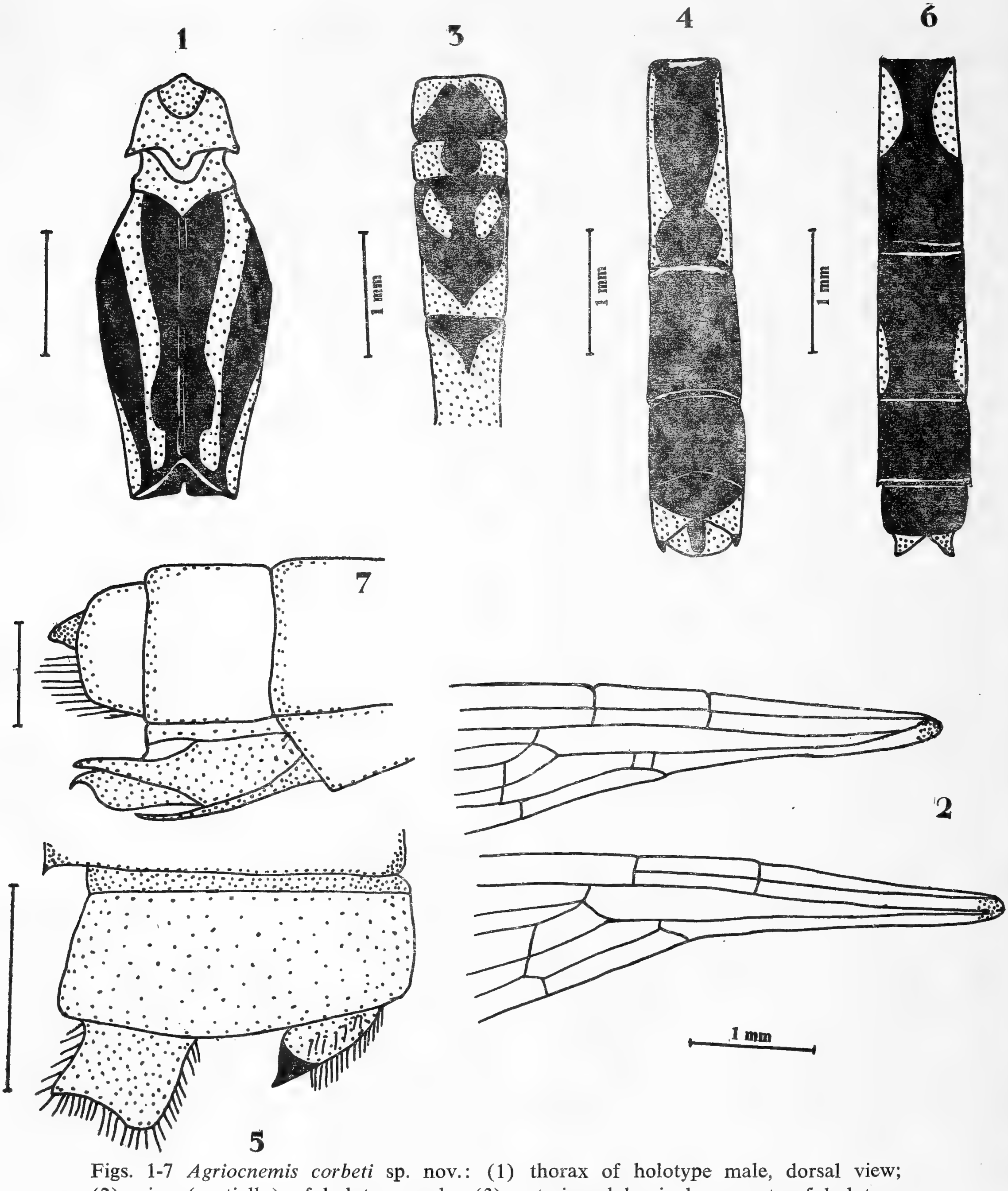
1♀ Allotype; India, Dehra Dun, Badripur Vill. 26.3.1976, Coll. A. Kumar.

1♀ Paratype: India, Dehra Dun, Badripur Vill. Em. from larva on 10.3.1976, Coll. A. Kumar.

3 ♀♀ Paratype: (1 ♀ from Badripur Vill. 26.3.1976) 2♀♀, India, Dehra Dun, Gorakhpur Vill., 27.4.1976, Coll. A. Kumar.

Holotype and 2 paratype ♀♀ will be deposited in the National Collection of the Zoological Survey of India, Calcutta; Allotype and rest of paratype ♀♀ will be retained in the Northern Regional Station, Zoological Survey of India, Dehra Dun.

Diagnosis: This species falls under Group 2 of Fraser (1933) in which the labrum is non-metallic and anal appendages more or less homogeneous, the superior is longer than inferior. This species can be easily distinguished from all other known species of the genus *Agriocnemis* Selys by its brownish red thorax, brick-red abdomen and with black markings and can be easily separted from *Agriocnemis pygmaea* (Rambur), *A. clauseni* Fraser and *A. nainitalensis* Sahni from this area in having light reddish brown prothorax; pale yellow



Figs. 1-7 *Agriocnemis corbeti* sp. nov.: (1) thorax of holotype male, dorsal view; (2) wing (partially) of holotype male; (3) anterior abdominal segments of holotype male; (4) posterior abdominal segments of holotype male; (5) anal appendages of holotype male, lateral view; (6) posterior abdominal segments of allotype female; (7) reproductive organs of allotype female.

anal appendages; superior anal appendages pale yellow and tipped with black.

LARVA (Figs. 8-16)

Material: India: U.P., Dehra Dun, Badripur Vill., 8.3.1976, 3 larvae (1♂, 2♀♀) marshy pond, emerged in Laboratory on 10.3.1976 (♀), 11.3.1976 (♂ Holotype) and (♀ Paratype), Coll. A. Kumar.

Description: Length 17.1 mm (varying from 16.8 to 17.1 mm.); Caudal lamellae (paraprect) 5.7 mm. *Coloration* — uniformly pale brown except caudal lamellae which are darker.

Antennae (Fgs. 9 & 10)—filiform, flagellar segments beset with a few setae towards apical half; measurements (in mm) of segments being 0.20, 0.30, 0.36, 0.27, 0.23, 0.14 and 0.11; total length 1.61 mm.

Labium (Figs. 11 & 12)—premental setae 4-4, a few spiniform setae present laterally on prementum; palpal setae 5 & 5, distal margin of palpus divided into two lobes, outer lobe bear 4 distinct and a few small teeth, while the inner terminates into a curved end hook. Movable hook medium-sized about half of the length of palpus.

Tibial comb (Fig. 14)—comprises a number of scattered tridentate setae in between which some long simple setae also present; tarsi beset with a double row of pectinate setae on their outer side.

Gonapophyses—in male triangular process situated ventrally on posterior side of 9th abdominal segment; in female arising from anterior side of 9th segment and extending up to posterior half of 10th segment.

Caudal lamellae (Figs. 15 & 16)—epiproct and paraprocts in the form of fusiform, duplex lamellae; leaflike, with apices ending into narrow process. Mottled with 5 distinct cross bands in paraprocts, 3 in epiproct from middle to apical end; darkish basally. Tracheation well developed, a number of undulating secondary and tertiary branches arise from the main median trachea. Antenodal region beset with evenly arranged row of spiniform setae (fig. 16). Length epiproct 5.1 mm.; paraprocts 5.8 mm.

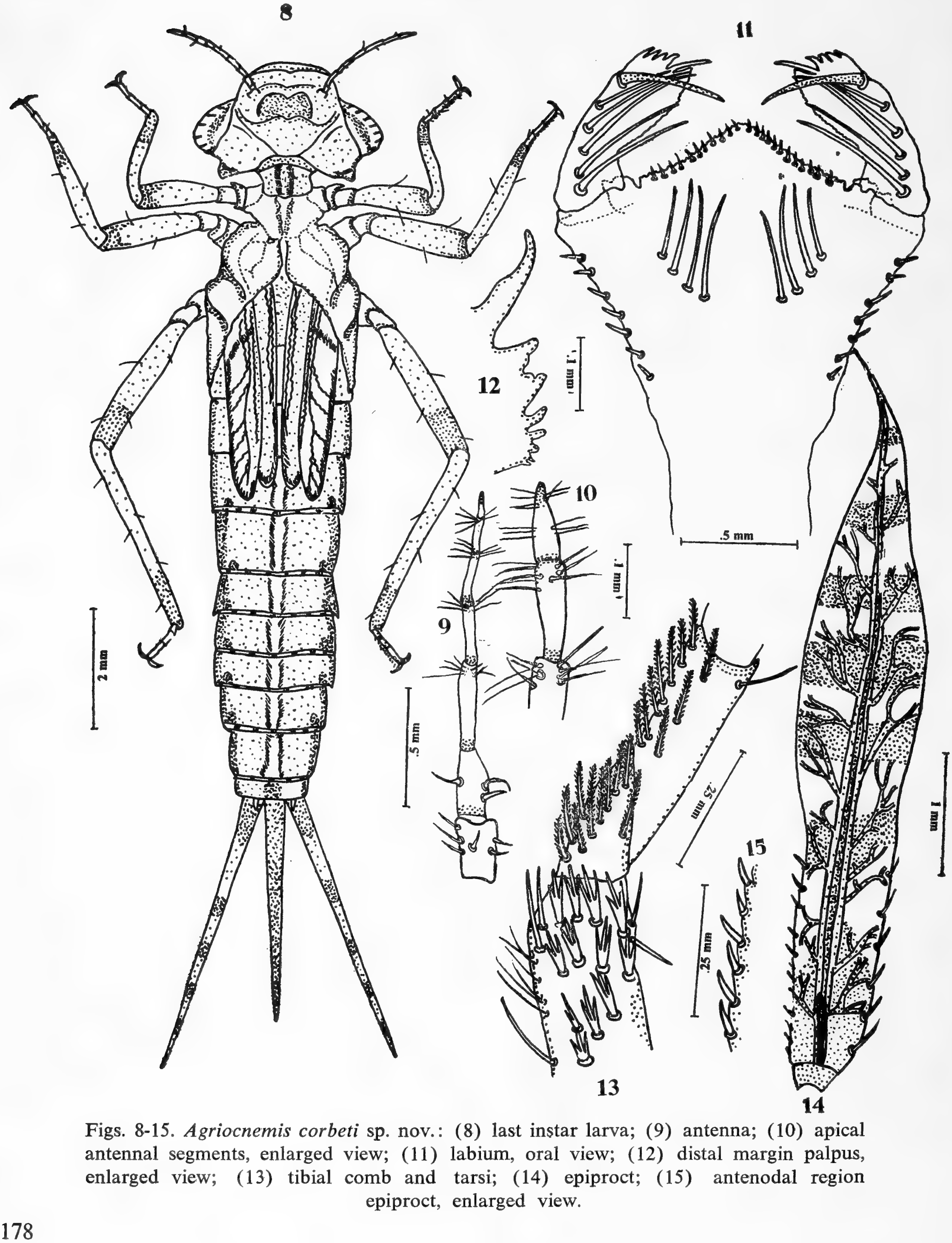
Biology: Larvae have been so far collected only from a marshy pond at Badripur Vill., Dehra Dun. They are active in habit and remain attached to submerged vegetation. The same pond also holds larval population of *Agriocnemis pygmaea* (Rambur) and *Ischnura delicata* (Hagen).

Adults are rare but have been observed on wing from middle of march to end of April. Females were seen flying amidst grass on the marshy bank of the pond. One female was also collected from another perennial pond (Gorakhpur Vill.) on 27.4.1976 about 1 km from type locality of this species.

Diagnosis:

The other two species of *Agriocnemis* from the Indian subregion whose larvae are known are *A. femina* (Lieftinck. 1962) and *A. pygmaea* (Kumar 1973).

Larvae of *A. corbeti* sp. nov. can easily be differentiated from that of *A. pygmaea* by their coloration, size and the number of labial setae (*A. pygmaea* premental setae 3-3; palpal setae 4-4). However, the larvae *A. femina* are close to those of *A. corbeti* in having the same number of labial setae (number being premental setae 4-4, palpal setae 5 & 5 in both) but can be easily differentiated on the basis of size; the larvae of *A. corbeti* are distinctly larger in size (larvae of *A. femina* are only about 12.5 mm in length).



Figs. 8-15. *Agriocnemis corbeti* sp. nov.: (8) last instar larva; (9) antenna; (10) apical antennal segments, enlarged view; (11) labium, oral view; (12) distal margin palpus, enlarged view; (13) tibial comb and tarsi; (14) epiproct; (15) antenodal region epiproct, enlarged view.

ACKNOWLEDGEMENTS

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A NEW SPECIES OF KRAIT OF THE GENUS *BUNGARUS* DAUDIN, 1803 [SERPENTES: ELAPIDAE] FROM THE ANDAMAN ISLAND[1]

S. BISWAS AND D. P. SANYAL[2]

(*With four text figures*)

INTRODUCTION

In course of a study of the reptiles of Andaman and Nicobar Islands in the collections of the Zoological Survey of India we came across four specimens identified earlier as *Bungarus caeruleus* (Schneider) and which showed marked differences from *B. caeruleus* and are now being described as of a new species.

Bungarus andamanensis sp. nov.

Description : Head not distinct from neck; eye with round pupil diameter more than half the distance of eye and the nostril; nostril between two nasals; rostral broader than long; internasal broader than long and shorter than prefrontal; prefrontal broader than long, length more than half its breadth, touches internasal, postnasal, preocular and supraocular; frontal slightly shorter than its distance from the rostral and touches six shields, excepting frontoparietal all subequal to frontal; frontoparietal largest; no loreal; one preocular in contact with posterior nasal, two postoculars; width of supraocular more than half its length; temporal 1 + 2; 7 supralabials, 1st and 2nd touching nasal, 3rd and 4th in contact with eye, 2nd decidedly narrower than 3rd, 5th highest touching postocular and anterior temporal, 6th largest and broadest and touching anterior temporal; 7 infralabials, 1st longer than 2nd and 3rd, these touch anterior genial, 4th in contact with posterior genial, 6th longest;

[1] Accepted December 1977.

[2] Zoological Survey of India, Calcutta-700 012.

anterior genial longer than posterior; dorsal scales smooth and shining, in 15 rows; vertebral series strongly enlarged, broader than long and also broader than the scale of 1st row, ventral 194; anal undivided; subcaudal 47 and undivided; tail thick, ends in a blunt point.

Dorsal coloration of preserved specimen in spirit, chocolate or reddish black, lustrous and shining; 44 white linear arches or bars across back and 12 on tail, arranged equidistantly; bars complete dorsally, mottled with brown, laterally expand abruptly; top of head chocolate fading to white on the lip, belly glazed white, anterior and lateral margin of ventral scales tinged with brown.

Measurements (in mm) and count:

	Holotype 20895/1	Paratypes 20895/2	2897	14628
Snout to vent	600	410	222	184
Vent to tip of tail	115	77	41	34
Total length	715	487	263	218
Total length/tail	5.2	5.3	5.4	54
Head length up to parietal	19	11.5	8.5	8
Head breadth at broadest	16	9.5	6.5	5.5
Diameter of eye	2.5	1.8	1.5	1
Eye to snout	6.3	4.6	2.5	2
Eye to nostril	3.5	2.8	1.5	1.2
Number of ventrals	194	192	197	193
Number of subcaudals	47	45	46	45
Dorsal scales	15	15	15	15

Material examined: Holotype Zoological Survey of India, Reg. No. 20895/1, Port Blair, S. Andaman; collected by A. Bayley de Castro, 18 June 1926.

Paratypes: Zoological Survey of India, Reg. No. 20895/2, Port Blair, S. Andaman, collected by A. Bayley de Castro, 18 June 1926. Reg. No. 2897, Andaman, collected by R. C. Tytler, registered on Jan. 1944. Reg. No. 14628, Andamans, collected by Major A. R. Anderson, registered on Jan. 1947.

Remarks: The entire collection of *Bungarus caeruleus* (Schneider) in the Zoological Survey of India consisting of 51 specimens, 4 from Andaman Island and rest from different parts of India were examined, but the four specimens from Andaman having ventral from 193 to 197, subcaudal 45 to 47, complete and equidistant body cross-bars from 39 to 47 and the tail bars from 9 to 13 maintain a uniform distinction from the mainland specimens of *Bungarus caeruleus* which have ventral count from 200-217, subcaudal 33 to 52, 29 to 65 cross-bars in pairs and tail bars 4 to 27. Moreover some of the anterior body cross-bars from 2 to 15 are dorsally incomplete. The body to tail ratio in the present species is 5.2 to 5.4 whereas in *caeruleus* it is 8.

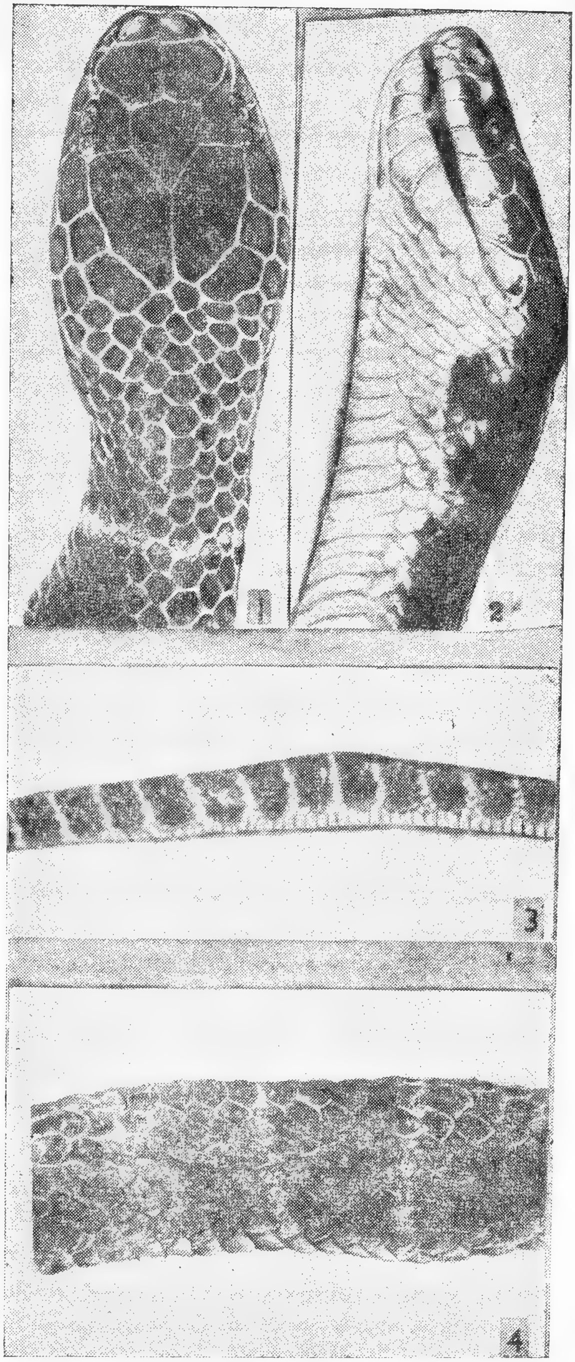
Wall (1908) was not able to correctly decide the status of the Andaman specimen because he examined a juvenile specimen of Zoological Survey of India (a specimen from

Indian Museum, pl. viii, fig. 4) and assigned this specimen to *B. multicinctus* (Blyth) lowering the ventral count of this species from 219-236 to 194-218 though the specimen differs from the *multicinctus* not only in the ventral count but also in other characters, such as 2nd supralabial not decidedly narrower than the 3rd, in the disposition and arrangement of colour bars, body to tail ratio and in having a different geographical distribution.

Smith (1943) also noticed these differences in the six specimens he examined from Andaman and noted correctly the characters as "scales in 15 rows throughout, V.192-200, C.40-46. Black above, with narrow white equidistant cross-bars, 40-46 in number on body; these are equally distinct throughout body, and have no vertebral spots" but he thought these differences are due to juvenile condition of the specimens and brought them under the broad range of scale count, dorsal 15 to 17, ventral 194-234, caudal 42-52 along with the specimens of *B. sindanus* (Boulenger [17 dorsal, vertebral not broader than long, V.218-237, C.48-52] which has got a valid claim of a distinct taxonomic status, but according to Smith the claim is untenable due to their common geographical distribution and variation of characters.

Smith's above quoted observation was no doubt correct, but he was also misled like Wall in assigning the Andaman specimens to *B. caeruleus* as he examined only the juvenile specimens in the collections of the Zoological Survey of India, instead of the adult.

The juvenile or young specimens appear markedly different from the adult coloration. Though the body bands in juvenile (Fig. 3) are equidistant, the body colour is very prominent and uniformly chocolate without the mottled marking within the white bars as in the Holotype. The latero-ventral ends of the



white bars also spread abruptly.

The comparative chart of different characters of 5 species from the Indo-Malayan region given below show the gradual differentiation of characters within the *caeruleus* species complex:

Characters	*B. andamanensis*	*B. caeruleus*	*B. candidus*	*B. multicinctus*	*B. ceylonicus*
Ventrals	192-197	200–217 (234)	209–219	209–228	219–236
Subcaudals	45–47	33–52	40–50	44–54	32–42
2nd supralabial decidedly narrower than 3rd.	yes	As broad as the 3rd	?	No.	yes, also narrower than 1st.
Body bands	39–47	29–65	20–25	27–48	15–21
Tail bands	9–13	4–27	7–10	7–13	2–5
Coloration and band arrangements	Equidistant, compete, narrow white bars and wider on the sides comparatively less and abruptly, bars are mottled.	In pairs, narrow on the vertebral line wider on the sides; broken up into spots, some anterior bars incomplete.	Black body, bars on the fore part of body narrower than interspeces, on the hinder part about same width.	Bars on the fore part of body further apart from one another than on hinder part, median portion of each bar may be spotted black.	Alteranate black and white bands which encircle body. In old specimens dorsal white bands tend to reduce to vertebral spots or sometimes disappear.
Measurement of largest (Body + tail)	600+115 mm	1200+150 mm	1070+135 mm	1100+145 mm	1000+95 mm

KEY TO THE SPECIES *Bungarus* BELONGING TO THE *caeruleus* GROUP OF SPECIES

A. Scales in 15 rows.
  B. Subcaudals entire throughout.
    C. Vertebrals strongly enlarged, as broad as or broader than long.
D. Tail ending in a point, dorsal vertebrae not forming a ridge down the back.
  E_1 Belly uniformly white.
    Back uniformly black above, C.49-56......
      B. niger Wall. (E. Himalayas and Assam)
  F_1 Bands are arranged in pairs.
    Back with 27-48 white cross-bars; V.200-217, C.33-52. .. ..
      B. caeruleus Schneider. (India & Sri Lanka)
  F_2 Bands are not arranged in pairs.
    1. Back with narrow white cross-bars, arranged equidistantly; V.192-197, C.45-47.
       B. andamanensis sp. n. (Andaman only)
    2. Back with bars on anterior part further apart from one another than on hinder part; V.209-228, C.44-54 .. ..
       B. multicinctus Blyth. (Burma, Indo-China, S. China)
    3. Bars on the fore part of body narrower than interspaces, on the hinder part about same width.

Back of tail with 20-25 broad white cross-bars, median part of each bar spotted with black; V.209-229, C.40-50 .. ..
B. candidus (Linn.). (Thailand, Malay Pen. and Indonesia)

E_2 Belly with black marks or cross-bars, sometimes absent in juvenile.

1. Back with 15-21 white cross-bars, 2-5 tail bands. V.219-236, C.32-42. ....
B. ceylonicus Gunther. (Sri Lanka only)
2. Back with 11-14 very broad, white, black-spotted cross-bars; V.214-235, C.40-48. .. .. *B. magnimaculatus* Wall and Evans. (Burma only)

ACKNOWLEDGEMENT

We are thankful to the Director, Zoological Survey of India, Calcutta for facilities provided to study the material.

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STUDIES ON INDIAN FILISTATID SPIDERS (ARANEAE: ARACHNIDA)[1]

B. H. PATEL[2]

(*With two text-figures*)

INTRODUCTION

Since the classical work of Pocock (1900) and the earlier contributions of other European arachnologists on Indian spiders, no reference has 'been made about the occurrence of filistatid forms from India. The earliest record was by Thorell (1895) from Burma with a description of a new species *Filistata zebrata*. Simon (1911) described *F. nigra* from Madura, India; now confirmed by Benoit (1968) as *Sahastata nigra*. Recently Tikader (1963, 1977) described two and Patel (1975) described one species of the genus *Filistata* Latr. from India. Recently (May, 1977) I studied the type specimens of *F. poonaensis* and *F. nicobarensis* from the Zoological Survey of India, Poona and found that both species belong to the genus *Pritha*. The conclusion of Lehtinen (1967) that *F. poonaensis* Tikader, is a species of *Pritha* is thus confirmed.

Filistatidae is a family of Cribellate spiders, living in dark places, particularly in crevices of houses, wood and also under stones. Only one genus, *Filistata* was known which was considered to have world wide distribution. Mello-Leitao (1946) described some more Neotropical genera and summarized the characters of the known genera. Recently Lehtinen (1967) clearly separated four more genera *Andoharano, Kukulcania, Zaitunia* and *Pritha,* and redefined the genus *Filistata,* limited in distribution to areas south of the Palaearctic region. According to Benoit (1968) the first three

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genera described by Lehtinen are monophyletic.

During the course of my studies on spiders from Gujarat State, I came across some interesting forms of this family belonging to the genera *Sahastata* Benoit and *Pritha* Lehtinen. The first genus is being recorded here for the first time after its establishment by Benoit and the later also for the first time from India. The previous records of *Pritha* are from Algeria, Lybia and Tunisia. Two new species of these genera are described here. A Key to the Indian filistatid genera as well as the characters of the newly recorded genera are given.

The type specimens will in due course be deposited in the National Collections of Zoological Survey of India, Calcutta.

Key to Indian Filistatid Genera

1. —Calamistrum of curved hairs in a single row. Cephalothorax with a central marking and black margin. Femora III and IV with basodorsal spines, tarsi III and IV with spines in a single row. .. .. *Filistata*
   —Calamistrum in two rows (biserrate) 2
2. —Cribellum subtriangular. Cephalothorax slightly marked with black designs, cymbium horse-shoe shaped. Tibia of maxillary palp much swollen, femur and tarsi without spines. Abdomen with white hairy patches. .. .. *Pritha*
   —Cribellum subtriangular, narrow and elongated lengthwise. Cephalothorax marked anteriorly with black network like markings. Cymbium short and cylindrical. Tibia of maxillary palp is not swollen. 3
3. —Outer row of calamistrum is of short hairs and inner row has long curved hairs. Scopulae on inner side of femora I and II, and numerous spines on femur II; tibia, metatarsus and tarsi with numerous spines. .. .. *Sahastata*

Filistata Latreille 1810

Filistata Latreille, 1810. Consi. gen. Crus. Arach. Ins., : 120.

Filistata napadensis Patel, 1975. *Oriental insects, 9*(4) : 425.

Specimens examined: Gujarat: Napad, Dist. Kheda, 20 ♀, 2 ♂, 18.x.1967; Vallabh Vidyanagar and Chaklashi, Dist. Kheda, 3 ♀, 20.xi.1969; Ahwa, Dist. Dangs, 2 ♀, 16.viii. 1970; Ambaji, Dist. Banaskantha, 2 ♀, 21. xi.1970. Coll. B. H. Patel.

Distribution: Kheda, Ahwa and Banaskantha Districts, Gujarat.

Pritha Lehtinen 1967

Pritha Lehtinen, 1967. *Ann. Zool. Fennici, 4* : 260, 300.

Characters: Cephalothorax with light coloured designed and well defined clusters of white hairs. Tarsal claws without spines, some times a small ventral spine on the metatarsus I present. Thoracic fovea absent. Cribellum triangular and divided. Calamistrum biserrate. Male: cymbium horse-shoe shaped. Tibia of palp strongly bulged, the ejaculatory duct very broad and 'U' shaped with embulous end sharp and slightly arched. The palp of the female is more swollen than in other genera. Male cephalothorax is bordered.

Type species: *Pritha mana* (Simon 1868).

This common genus is heterogenous in its composition and was divided into three groups of species by Lehtinen (1967). Palaearctic (*nana*) group comprises of *P. nana* Simon, *P. vestata* Simon, *P. debilis* Simon, *P. pallida* Kulcz. and *P. albimaculata* O. P. Cambr. to which *P. condita* O. P. Cambr. from Atlantic Islands is added. The other groups are the Indo-Malayasian (*garciai*) group and the

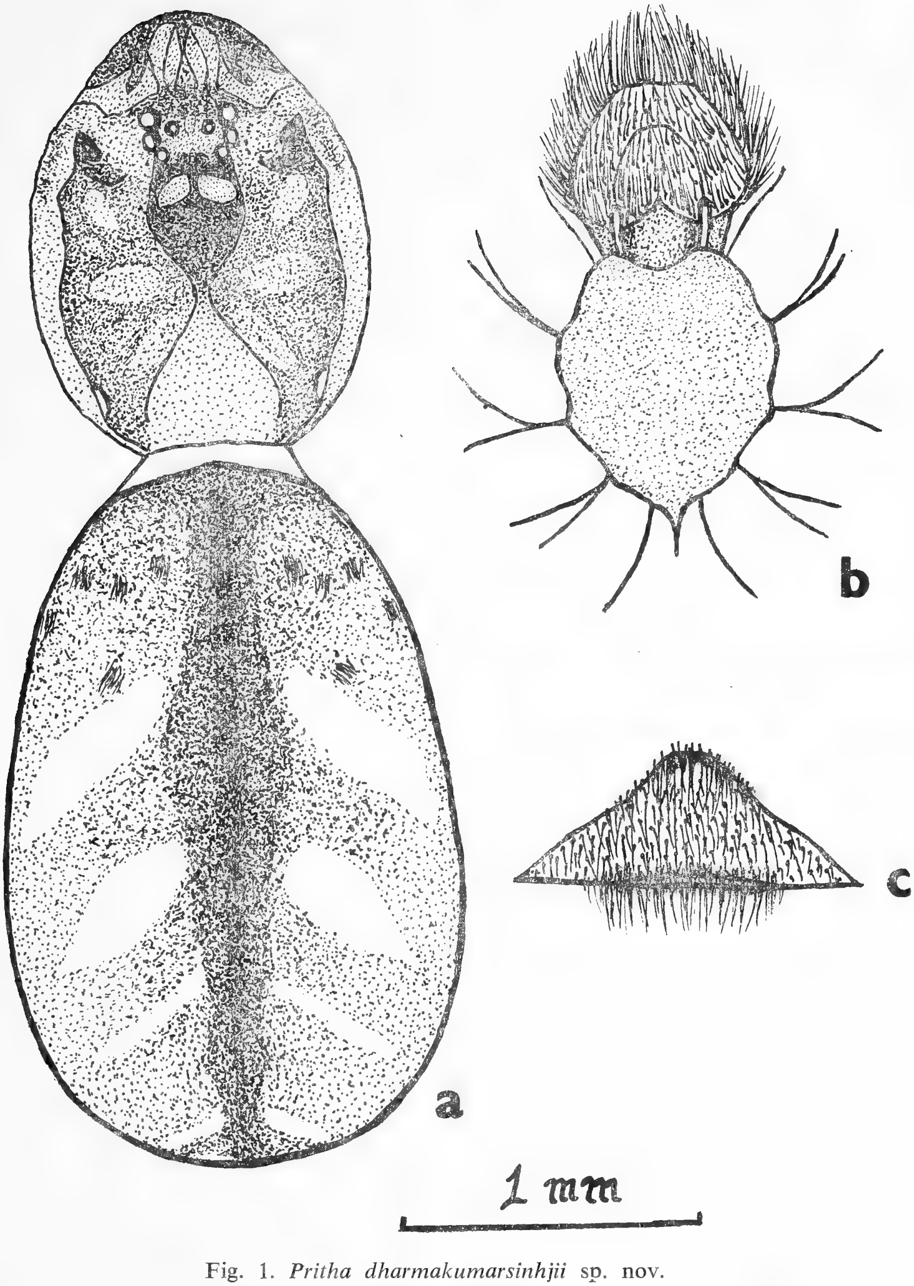

Fig. 1. *Pritha dharmakumarsinhjii* sp. nov.
a. Dorsal view of female (legs omitted); b. Sternum, labium and maxillae; c. Epigyne.

Formosan (*bakeri*) group of which the first one is closer to the Palaearctic one.

Pritha poonaensis (Tikader)

Filistata poonaensis (Tikader), 1963. *J. Univ. Poona Sci. Tech. 24*:35. *Specimens examined*: Gujarat: Napad, Dist. Kheda, 2 ♀, 3.ix.1967; Chaklashi, Dist. Kheda, 2 ♀, 22. vi.1970. Coll. B. H. Patel. Also type specimens from the collections of Z. S. I., Poona, collected by Dr. B. K. Tikader.

Distribution: Poona, Maharashtra; Kheda District, Gujarat.

Pritha nicobarensis (Tikader)

Filistata nicobarensis (Tikader), 1977. *Rec. Zool. Surv. India, 72* (1-4):160.

Specimens examined: Female holotype and paratypes from the collections of Zoological Survey of India, Poona, collected by Dr. B. K. Tikader.

Distribution: India: Nicobar Islands.

Pritha dharmakumarsinhjii sp. nov.
(Fig. 1, a-c)

Female: Light brown to brown in colour. Total length 3.83 mm. Carapace 1.46 mm long, 1.13 mm wide; abdomen 2.37 mm long, 1.46 mm wide.

Cephalothorax: Dark brown with light coloured white patches, covered with fine hairs and yellow coloured margin. Peculiar oval and round patches on the clypeus and the region just posterior to the eye group as in Fig. 1, a. Clypeus very low and arched. Eyes in a compact group and raised up. AM dark in colour, rest pearly white. AL largest of all, PM smallest, PL smaller than AL, AM slightly smaller than PM, AL and PL contiguous. Ocular quad broader posteriorly and narrowed in front. Anterior row of eyes procurved, posterior row slightly procurved. Sternum dark brown due to the presence of black spots; oval pointed behind and concave ridge in front. Sternum and labium fused together without any distinct demarkation. Sternum, labium and maxilla as in Fig. 1, b. Two white stripes are present from the anterior edge of sternum joining with the labium on its lateral margin. Legs long, the first being the longest, yellowish with dorsal sides brighter in colour, covered with numerous hairs, no spines. Tarsi with two pectinate claws. Legs 1 4 2 3.

Abdomen: Oblong, brownish, with light yellow symmetrically arranged patches on the dorsal side and a median dark coloured line as in Fig. 1, a. Few scattered tufts of white hairs are present on the anterior half of abdomen. Ventral side lighter in colour with a wide median dark band extending from the epigastric fold upto the spinners. Abdomen projects a little behind the spinners. Epigyne most simple in the form of a transverse slit as in Fig. 1, c.

Holotype: 1 ♀, paratype: 4 ♀, in spirit.

Type-locality: Bhavnagar, Dist. Bhavnagar, 23.viii.1973. Coll. B. H. Patel.

Distribution: Bhavnagar and also collected from Hathab, Dist. Bhavnagar, Gujarat.

This species resembles to *Pritha nana* Lehtinen, but differs as follows: (1) Shape of sternum differs with the posterior pointed end and black spots. (2) Two white stripes on the lateral sides of labium joining the sternum and labium are present, but in *P. nana* no such stripes are found. (3) Colour pattern on the cephalothorax and abdomen also differ. (4) Epigyne also differs structurally.

SAHASTATA Benoit 1968

Sahastata Benoit, 1968. *Estr. Dag. Ann. Del. Mus. Civ. Stor. Nat. Genova, 77*:96.

Characters: Eyes in a compact group, raised on the turbercle like protrubrance, ocular region marked with raised hairs. Ocular quad wider behind. Clypeus more strongly arched. A deep fovea present. The area between the

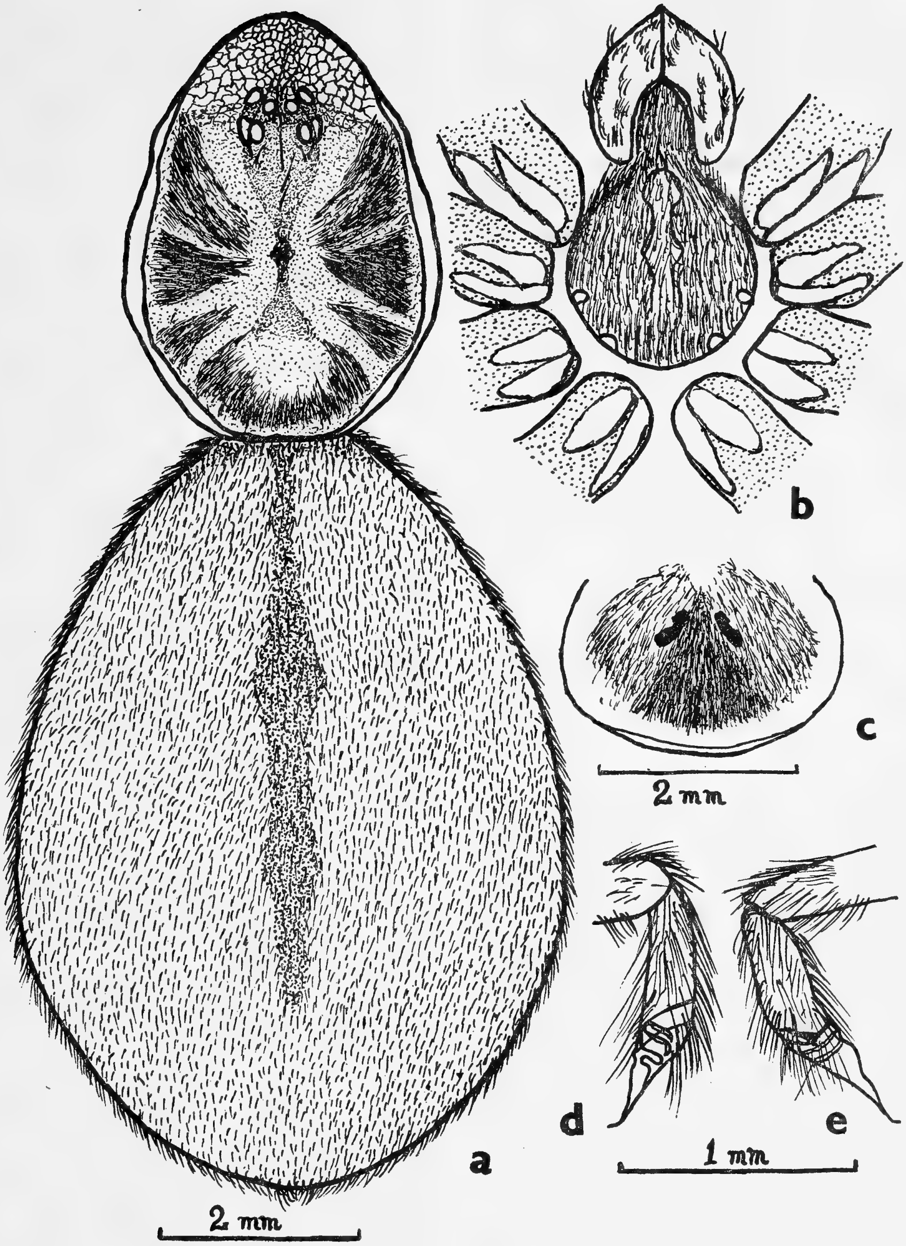

Fig. 2. *Sahastata ashapuriae* sp. nov.
a. Dorsal view of female (legs omitted); b. Sternum, labium and maxillae; c. Epigyne; d. Left male palp—inner view; e. Left male palp—outer view.

eyes and fovea is covered with stiff black hairs, pointing towards the median line. Tibia and tarsi of palp with a number of small ventral spines. Femora I and II provided with thick scopulae, thick hairs and numerous spines on femora II. Tibia, metatarsus and tarsus with a number of ventral spines. Pectinate tarsal claws present. Labium more longer than wide with lateral concave edges. Calamistrum of two rows of hairs, the inner row is of long curved hairs, towards the outer side over the outer row which is of short straight hairs. Cribellum divided transversely.

Type species: *Sahastata nigra* (Simon 1911)

This genus occupies an intermediate position between the old world genera of *Filistata* Latr. and *Zaitunia* Leht. and *Kukulcania* Leht. of the new world.

Sahastata ashapuriae sp. nov.
(Fig. 2, a-e)

Female: Brown to black brown in colour. Total length 11.73 mm. Carapace 4.21 mm long, 3.15 mm wide; abdomen 7.52 mm long, 5.47 mm wide.

Cephalothorax: Oval, longer than wide, widest through the region of fovea, with light coloured margin, clothed with hairs. Eyes in a small compact group on an elevated tubercle like protrubrance. AM more than twice smaller than AL, AM round and dark in colour, rest oval and pearly white, PL larger than PM, AL largest of all. Anterior row of eyes slightly procurved, posterior row nearly straight. Ocular quad narrower anteriorly and wider behind. The black marbled design is limited to the clypeus which is more or less flat and round in front. Carapace is covered with thick long black hairs pointing towards the median line. Postero-lateral sides of ocular tubercle show depression. Distinctly deep and wide fovea present, at the posterior end of which there is a depression as in Fig. 2, a. Sternum oval, narrow anteriorly, covered with hairs and four yellowish circular patches on the margin of posterior half. Labium longer than wide, pointed at the anterior end. Sternum, labium and maxilla as in Fig. 2, d. Coxae of all the legs having two light yellowish coloured patches as in Fig. 2, b. Legs long, covered with thick hairs. Femora I and II provided with thick scopulae. Tarsal claws provided with 10-12 long teeth. Legs 1 4 2 3. Calamistrum of two rows of hairs, the inner row is of long curved hairs, the outer row of straight hairs. Cribellum divided transversely.

Abdomen: Oval, longer than wide, wider in the posterior half, covered with thick hairs. The dorsal side provided with a median elongated patch of light yellowish colour ,as in Fig. 2, a. Ventral side lighter in colour. Epigyne as in Fig. 2, c.

Male: Similar in colour and characters but smaller in size than the female. Total length 5.89 mm. Legs comparatively longer than the female. Legs 1 4 2 3. Male palp longer than the first leg and palpal organ simple as in Fig. 2, d and e.

Holotype: 1 ♀, paratype: 5 ♀, allotype: 1 ♂, in spirit.

Type-locality: Hathab, Dist. Bhavnagar, *c*. 25 kilometres south of Bhavnagar, 1.ix.1973. Coll. B. H. Patel.

Distribution: Known from the type-locality and also from Bhavnagar, Dist. Bhavnagar, Gujarat.

This species resembles *Sahastata nigra* Benoit, but differs as follows: (1) Black marbled design is only on the clypeus region, but in *S. nigra* it entirely covers the cephalothorax. (2) Black, long and dense hairs cover the median line on the slope of ocular bulb, but in *S. nigra* this region is covered by the black design. (3) Structure of epigyne and male palpal organ also differ.

Acknowledgements

I am indebted to P. L. G. Benoit, Chief of the invertebrata Section, Royal Museum of Central Africa, Tervuren for the confirmation of the species and for valuable criticism. I am grateful to the authorities of the Saurashtra University, Rajkot for the sanction of grants (3147/21199 dated 7-3-1974). My sincere thanks are due to Dr. B. K. Tikader, Deputy Director, Z. S. I., Poona, Prof. J. J. Shah, Professor and Head, Dept. of Botany, S. P. University, Vallabh Vidyanagar, and Prof. H. B. Gohil and Principal Dr. L. D. Dave of Sir P. P. Institute of Science, Bhavnagar for their help and keen interest in my work.

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OBITUARY

SIR KEITH CANTLIE, K.C.I.E., I.C.S.

Indian entomology suffered a severe loss with the death of Sir Keith Cantlie, at the age of 91, on April 29, 1977. He belonged to that great band of British public servants in India for whom India became a second home and motherland—every Christmas he brought me up to date with a long synopsis of Assam affairs, and even at Christmas 1976 his comments and predictions were as clear as ever. For men such as Cantlie the life around them was of absorbing interest, and everything about it had to be savoured and, where necessary, explored and defined. A selection from his written work well illustrates this broad interest: a volume on the Customary Law of the Khasis, the book "Assam in Former Times", a monograph on the Revenue Laws of Assam and numerous notes in the Journal of the Bombay Natural History Society, culminating in the revised edition of the Lycaenidae section of Evan's "Identification of Indian Butterflies", published by the Society.

Cantlie must have inherited his gifted mind from his equally talented father, Sir James Cantlie, K.B.E., F.R.C.S., the founder and first president of the Royal Society of Tropical Medicine and Hygiene. He passed the I.C.S. examination in 1909 and was first posted to the short-lived amalgamated province of East Bengal and Assam, subsequently being placed on the Assam list. After war time service with a Mahratta battalion and later in Mesopotamia and Persia he was appointed in 1922 President of the Manipur State Durbar, and it was this appointment which probably shaped his future life and interests. It was at that period that he started collecting and studying butterflies in Manipur and Naga Hills, but though he never lost interest his busy service life—among other posts he was Commissioner of the Assam Valley 1937-42 and later a member of the Assam Revenue Tribunal—precluded much entomological work until his retirement. When the Japanese war threatened Assam he raised a Labour Corps of Khasis, and his last public service was as chairman of the Assam Public Service Commission. For his notable war time services he was awarded a knighthood.

Lady Cantlie died in 1945 and this made the decision to stay on in Shillong at the end of the war an easy one. At last he was able to pursue his interest in butterflies wholeheartedly, making frequent collecting trips in the Khasi Hills and Angami Naga country as well as buying butterflies from local collectors and dealers. This phase of his life was sadly terminated at Jhakama where he slipped on the steps of the inspection bungalow and fractured a knee cap, leaving him with a "gamey leg" which plagued him for the rest of his life and necessitated a final return to England. In London he worked equally hard at the British Museum of Natural History, going laboriously through General Tytler's tins of Manipur and Naga Hills papered specimens dating from around 1912, and eventually typing out and preparing for publication his revision of "Evans", a thoroughly exhausting and trying job at his then advanced age.

I was first introduced to Cantlie in 1947, and I owe an enormous debt to his warm encouragement and leading on of one who had great enthusiasm but little knowledge. No trouble was too great for him, and when he left Assam he checked all my doubtful specimens against British Museum material, often obtaining the advice of Brigadier Evans and Graham Howarth. One of the greatest pleasures of my life was to name my first "new" species *Ypthima cantliei*, in acknowledgement of his help and friendship and to honour for all time a very great man whose kindly manner, warm-hearted enthusiasm and sense of humour enriched the lives of all around him.

T. NORMAN

Articles and notes published by the late Sir Keith Cantlie in the Societys' *Journal*

More Butterflies of the Khasi and Jaintia Hills, Assam. Vol. 51:42.

Hesperidae of the Khasi and Jaintia Hills. Vol. 54:212.

A new variety of the butterfly *Rapala rissa ranta* Swinhoe. Vol. 56:652.

Butterfly notes from Assam: The undescribed female of *Ypthima atra*. Vol. 58:296.

Hesperiidae *Halpe scissa* sp. nov. Vol. 58:532.

Genitalia of the butterfly genus *Spindasis* Wallengren. Vol. 60:466.

Hesperiidae: *Polytremis minuta* Evans. Vol. 60:747.

Genitalia of the butterfly genera *Surendra* Moore and *Everes* Hubner. Vol. 61:201.

Genitalia of butterflies of the Hesperiid Genus *Caltoris* as figured by Evans. Vol. 64:580.

PATRICK DONALD STRACEY
(1906-1977)

Born on January 31, 1906, Patrick Donald Stracey secured his M.A. degree from Bangalore University and joined the Assam Forest Department as an Assistant Conservator of Forests on 9th November 1930, after being recruited to the Indian Forest Service. Two years later on the 5th February, 1933, he was promoted to the rank of the Deputy Conservator of Forests.

From 1934 Mr. Stracey was put in charge of the elephant hunting (*Kheda, Mela*) operations in different parts of Assam. It was during these operations, which kept him occupied for more than 8 years, that he learned all about the elephant wild and domesticated that made him one of the greatest experts on elephants in the World. During this period he was well known to almost all the famous 'Mahalders', 'Mahouts' and 'Phandis' of Assam and collected from them all the information on the methods of elephant catching operations in Assam, past and present. The record catch of 892 and 437 elephants in stockade operations in Mokakchang in Nagaland during 1935 and 1936 respectively stand to his credit to this day. His famous book 'Elephant Gold' is a testimony to his knowledge of the animal.

After serving for several years in the elephant catching operations he worked as the Divisional Forest Officer in different divisions of Assam and during this period became well known as a great sportsman and hunter in Assam. The record pair of elephant tusks from the Goalpara Forests displayed in the Assam Assembly House today were presented by him. The first sports stadium in Assam was established at Jorhat in 1951 by his untiring efforts. The National Sports Club of Assam and the Gauhati Stadium owe much to his pioneer selfless efforts. He was a good cricketer and golfer.

Mr. Stracey was promoted to the rank of Conservator of Forests in July, 1946, and became the head of the Forest Department as the Senior Conservator of Forests on the 15th August, 1947, the day India got her Independence. He became the Director of Forest Education in the Forest Research Institute, Govt. of India in March, 1955 and organised the Wildlife Club at the Institute and introduced wildlife preservation in the syllabus of the Indian Forest College and Rangers' Colleges. He was promoted as the Chief Conservator of Forests in March, 1959 and retired from Government service on January 31, 1961.

Mr. Stracey on retirement was given various assignments in foreign countries and later became consultant to State Governments in India in the matter of planning and development of Forestry. One of his last assignment was to assess the current status and future prospects of the Asian Elephants under the IUCN/SSC in which he was the Convenor of the North Eastern Task Force. He was one of the founders of the Wildlife Preservation Society of India, and continued as its Vice-President till his death.

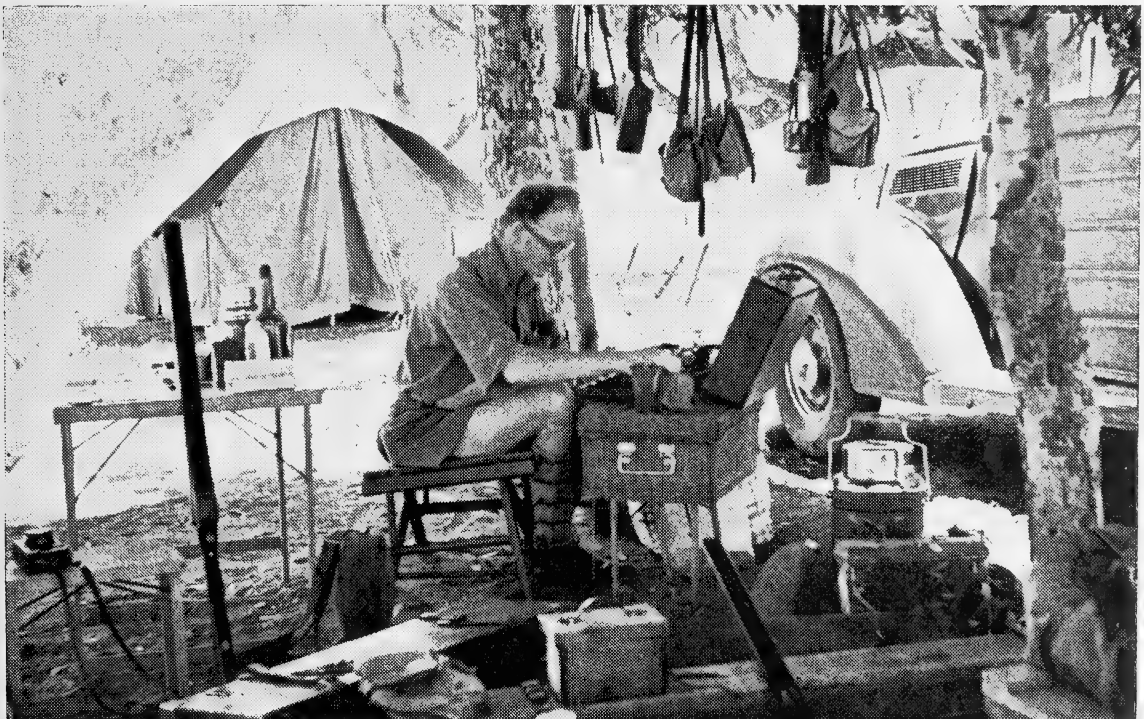
A prolific writer on wildlife conservation and management, many of his papers were published in journals all over the world. His books 'Elephant Gold', 'Wildlife Management of India' and 'Tigers' earned him laurels. In 1977 he was posthumously awarded the distinction of being included in its 'Roll of Honour' by the World Wildlife Fund.

He died on 9th June, 1977 at Bangalore after a brief illness.

L. C. DAS

RALPH CAMROUX MORRIS
(1894-1977)

Old-timers of the Bombay Natural History Society, and his many friends and admirers in India and abroad will be saddened by the death in London on 19 December 1977 of Randolph C. Morris, one of the oldest and most active members of the Society—an erstwhile coffee planter and owner of Honnametti Estate in the Biligirirangan Hills of Karnataka. Few readers of the *Journal* had heard of the Biligirirangan Hills before the 1920s. Their introduction to this fascinating corner of the country, and to the richness and diversity of its flora and fauna, especially the Big Game animals, came during the period between 1920 and 1958 through the shikar and natural history articles by R. C. Morris, a sportsman-naturalist in the finest tradition of an age that is past. He was a regular contributor to the Society's journal and I recall the tingling anticipation with which many a budding young naturalist of the time—and aspiring big game hunter to boot—looked forward to his evocative notes on local natural history and his exciting encounters with rogue elephants and cattle-slaying tigers and his penetrating observations on the habits and behaviour of the abounding wildlife amongst which he lived. Ralph's knowledge of the jungles around him and of their products and inhabitants was profound. His unquenchable thirst for inquiry and the acuteness of his powers of observation and deduction, and the versatility of his interests, will be evident from the appended list of his writings in the *Journal* during the period of his residence at Honnametti and of his greatest activity in those



RALPH CAMROUX MORRIS (1894-1977)
(Photo: *Sálim Ali*)

enchanting surroundings. Together with the contemporary writings of that other veteran sportsman-conservationist, Col. R. W. Burton, Ralph Morris's contributions—as E. P. Gee's at a later date—perhaps did more than anything else at the time to arouse the conscience of the thinking public and in creating an informed public opinion on the pressing need for wildlife conservation in India in the face of the rapidly deteriorating conditions. The destruction of forests for cultivation and settlement of an ever expanding population, and for industrial development and other purposes in the dubious process of modernisation had gathered alarming pace especially since the 1914-18 World War. Indeed it was largely due to the crusading zeal of these stalwarts, spearheaded by the Bombay Natural History Society, that the All-India Conference for the Preservation of Wildlife was called by the Viceroy, Lord Willingdon, in Delhi in 1935, which paved the way, after our Independence, for the creation of the Indian Board for Wildlife and all the statutory measures for nature conservation that have flowed therefrom.

Ralph was born in 1894 at Attikan, the first of the four coffee estates in the Biligirirangan Hills to be planted in 1888 by his adventurous and pioneering father in the midst of virgin evergreen forest, miles away from civilization and without roads or communications of any sort. The country was inhabited only by adivasis of the Sholaga tribe, and stiff with truculent elephants who were often vehemently resentful of the unwelcome human encroachment on their pristine domains. By the time the elder Morris died in 1918, as a result of goring by a wounded boar, he and some of his relatives had opened up three more coffee estates in the area, the last and largest of which, Honnametti, was planted by Ralph himself.

Ralph was educated in England at the Blue Coat School and Blundell's in Devon before coming out to assist his father in the planting business. He joined the Society in the year 1919 being, at the time of his death, the second oldest living member. In 1919 he married Heather, the daughter of a Scottish planter in the neighbouring Nilgiris, A M. Kinlock, a well known shikari-naturalist member of the Bombay Natural History Society who, curiously enough, also got killed by a wounded wild boar! They made a harmonious couple with a close identity of temperaments and interests. Both were physically tough and completely self-reliant, revelling in their secluded life away from the bustle and hubbub of civilization, and sharing a deep love of the jungle and its denizens, both human and animal. In Heather, Ralph had found an ideal life partner, sagacious and efficient not only in managing the home but also the mundane business of running the estate with all the taxing and tiresome chores that went with it. Their unfailing liberality and selfless consideration for the plantation labour were fully reciprocated and went a long way towards maintaining harmonious employer-employee relations on the estate and amicable co-existence with their aboriginal neighbours. It was the friendly ties with the tribals that helped Ralph to gather his vast store of local natural history and jungle lore from his trusty sholaga trackers.

With the sponsorship of Mr. Arther S. Vernay, an American business magnate, Ralph jointly led the Vernay-Hopwood expedition to the remote Upper Chindwin region of Burma in 1935 to collect zoological specimens for the Asiatic Hall of the American Museum of Natural History, New York; in the same year he led another field expedition for the same in stitution, this time to the Malayan jungles,

to look (unsuccessfully) for the Javan or Lesser Onehorned Rhinoceros (*Rhinoceros sondaicus*). His accounts of these expeditions, published in the BNHS *Journal,* make interesting reading and are valuable records.

For 18 months in 1937-38 Ralph was the President of the United Planters' Association of South India and during Hitler's war (1939-45) he joined up as a volunteer officer, and saw active service in the Middle East and North Africa, notably in the siege of Tobruk. In the six years of his absence his wife ran the estate single-handed with unimpaired efficiency and marked success.

From the time of his return from war service, and up to India's Independence, he represented the South Indian Europeans in the Legislative Assembly in New Delhi. In 1955 he finally sold Honnametti Estate to the Birlas to return and settle in the U.K. where two of his three married daughters had already preceded him, the third being in the U.S.A. In the U.K. Ralph continued to strive for the conservation of Indian wildlife and was for many years, till his health began to fail, an active council member of the Fauna Preservation Society.

Those of Ralph's naturalist and shikari friends, like the writer, who enjoyed the privilege from time to time of being house guests in the Morrises' delightful home at Honnametti and of joining the indefatigable pair in rambles among those fascinating hills, or in quest of big game to shoot or photograph, will recall with the deepest nostalgia the informal graciousness of their hospitality and the atmosphere of affectionate warmth and sincerity pervading the entire experience. Small wonder that their friends, and such of the plantation labour and tribal sholagas as are alive after these 30 years, should still remember and speak of the couple with so much genuine admiration and respect.

SALIM ALI

Articles and notes published by the late Mr. R. C. Morris in the Society's *Journal.*

Birds

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On the occurrence of the Banded Crake (*Rallus e. amauroptera*) and the Malabar Woodpecker (*Macropicus j. hodgsoni*) in the Biligirirangan Hills, S. India. Vol. 40: 763
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REVIEWS

1. RAILS OF THE WORLD. A Monograph of the family Rallidae. By S. Dillon Ripley. pp. xx + 460 (25.5 × 35.5 cm). With 41 paintings by J. Fenwick Lansdowne, 10 black-and-white photographs, 17 distribution maps, and a chapter on Fossil Rallidae by Storrs L. Olson. David R. Godine. Boston, 1977. M. F. Feheley Publishers Ltd. Price U.S. $ 75.

Dr. Ripley met his first rail of the subtropics 40 years ago on an expedition in the mountains of New Guinea. Since then he has focussed special interest on the family Rallidae, and for the last 12 years he has been sedulously active in studying rails in the field in different corners of the world and in researching all available literature concerning this fascinating group. As long ago as 1893 Alfred Newton in his *Dictionary of Birds* had drawn attention to the scantiness of our knowledge of the rail family, and to the need of a comprehensive monograph on it, but the challenge remained unaccepted in the intervening 80 years. On all counts therefore, such a book as the present was to be welcomed. It is true that because of the secretive and retiring habits of this family, and the fact that many of the species are crepuscular or nocturnal and difficult to observe, not a very great deal has been added to our knowledge of their ecology and life history. Details of the biology of many species still remain very imperfectly known or are totally lacking. But a comprehensive summary of the existing knowledge was a long felt want which this monograph adequately fulfills. However, though rarely showing themselves, their presence can usually be detected by their ready response to played-back tape recordings of rail calls, and by mist netting. Such modern devices should help to add more rapidly to our knowledge of these elusive creatures.

The family Rallidae—consisting of rails, crakes, coots, moorhens, etc.—has a practically worldwide distribution. It is represented on all continents but is absent in the Arctic and Antarctic. Its members inhabit widely diverse habitats. Most species effect freshwater swamps; some estuaries and salt marshes. Some species are found in littoral grassland and savannahs, some even in tropical climax forest and often at considerable altitudes in the mountains. Although they have shortish rounded wings and are generally poor fliers, some are capable of crossing vast stretches of ocean and even of performing regular long-distance migrations. Herein lies the special attraction of the rail family for the biologist. These birds, above all others, have spread and colonized remote archipelagos and oceanic islands where, after establishment, their sedentary and parochial habits have contributed to the evolution of a spate of endemic and ecological races, and a tendency to flightlessness as an adaptive measure—a state which some forms have fully attained. Loss of flight renders the endemic island forms vulnerable to the rats and various domestic animals introduced via visiting ships or by sailors. Some of these flightless species have thus become extinct within the last hundred years or so,

while others in like circumstances are similarly threatened. In developing countries everywhere the prime habitats of this family are being extinguished by the destruction of forests, reclamation of marshes, diverting and impounding streams, and so on. Thus, in spite of the global distribution of the family and its surprising resilience, it is evident that many of its components especially the endemic island populations, particularly flightless forms, are extremely fragile and need stringent protection if they are to survive.

Against the 45 genera hitherto recognised, the present monograph admits only 18. The explanation given for the 'lumping' seems logical enough to the reviewer, but this is really a matter for taxonomers to worry about and battle over, because in the final reckoning any decision must rest largely on subjective individual taste and fancy! These 18 genera are made up of 129 species (some monotypic, others with subspecies) six of which are extinct and two probably so. Every species is illustrated in colour. The text comprises five chapters as follows: The Characteristics of the Rails, The Distribution of the Rails, Evolution and Speciation, The Species of Rails, A Synopsis of the Fossil Rallidae. Besides the description and general remarks on each species, there is a description of the subspecies, if any, together with synonyms. Status, distribution, behaviour, nesting and other topics of general and ecological interest are more fully discussed in the case of the better known forms.

This sumptuous volume is obviously designed as a 'coffee-table edition' in the Audubon/Gould tradition, for drawing room leafing and the library reading room table. The utility of elaborate keys to species and subspecies in a volume of this genre and 'physique' (it weighs six lbs!) which could understandably inhibit frequent reference as a working manual in a normally over crowded departmental laboratory, may be questioned. However, since it may be a long time before another equally competent reviewer and monographer of the family appears on the scene, it is as well that all the meticulously researched information and the author's own observations have been included. Considering the importance of the work it is to be hoped that Dr. Ripley will consider bringing out a more portable edition, retaining all the plates in the reduced size, and more within the budget range of modest scientific libraries and working ornithologists and nature lovers. The magnificence of Lansdowne's superb life-like paintings, which the reviewer had the privilege of viewing in the original, and the outstanding excellence of the colour reproduction by the firm of Stamperia Valdonega of Italy make it a joy to handle the volume. It seems a pity, however, that no scale of size is indicated along with the captions, which makes it difficult to get a proper idea in the case of unfamiliar exotic forms.

The literature cited covers 15 pages and is indicative of the erudition and enormous toil that have gone into the making of this seminal volume. It is a landmark in the field of modern bird books: a monument to the scientific acumen of the versatile author, no less than to the skill of the gifted artist.

SALIM ALI

2. WILD LIFE AND ADVENTURES IN INDIAN FORESTS—from diaries of B. B. Osmaston, Imperial Forest Service, 1888-1923. pp. 178 (26 × 20 cm). Published by G. H. Osmaston in 1977. Price £ 7.

The diarist's name is familiar to all who have had anything to do with natural history in India and to anyone who has delved into the earlier issues of the Society's *Journal*—the obituary note published on pages 709-710 of volume 60 (1963) carries a list of some 40 notes and papers contributed by him between 18 and 19 centuries and includes some of the natural history highlights of the present publication.

Brought together they present a fascinating series of experiences of the days when large parts of India were still forested and the Imperial Forest Service was still the dream of those interested in natural history and shikar. His first posting in Dehra Dun district brought him face to face with the Mundali man-eater, and we have an exciting account of the tigress being shot as she held B.B.'s companion, Hansard, by the neck. Hansard had to be carried 60 miles across the hills on a stretcher to get him to the Mussoorie hospital! Following this adventure he continued his service through Saharanpur, Garhwal, Kumaon, Chittagong, Darjeeling, the Andamans, including Narcondam and Barren islands, the Nicobars, again in U.P., and then into Burma, and the diary is interspersed with tigers, elephants, king cobras, partridge, pea-fowl, jungle fowl, rhododendrons, *Strobilanthes wallichii* (which flowers every 12 years), forest fires, 12-foot lilies and many bird notes some of which merit abstraction and publication in a scientific journal.

The book is an enchanting account of outdoor experiences in what was then one of the prime services and, once picked up, the book is difficult to put away. This small volume will also help to stress recognition of the fact that the natural history particularly in places like India is closely linked with Shikar, and that while the numbers and species that can be hunted would vary with conditions, and it is no longer possible for anybody to shoot about 20 each of tiger and panther, it must also be remembered, as indicated by Sir Harry Champion in the foreword, that B.B.'s victims included no less than four man-eaters and that the larger canivores were then so numerous and destructive that the officers were begged to deal with them.

Odd experiences over the period are included—and some are really odd. While birdwatching he comes face to face with a villager gathering fire wood, who drops his bundle and flees, but is, after a long chase downhill, brought down by Osmaston jumping upon him. After disentanglement, he produced a permit authorising him to collect fire-wood, and upon being asked why he had not shown it at first, said that he had taken him (B.B.) to be the Shaitan (Devil).

This is indeed a very fascinating record and serves to draw attention to what can be, and no doubt is, lost to natural history by the failure to keep written record of ones experiences.

H. ABDULALI

3. BACKS TO THE WALL—Saga of wildlife in Bihar—India. By S. P. Shahi. pp. 160 (27 × 21 cm), with many illustrations in colour and black-and-white. New Delhi, 1977. East-West Press Pvt. Ltd. Price Rs. 120/-.

What has alarmed conservationists and continues to alarm is the erosion of the areas of wilderness and the wildlife therein in India. Nothing draws more attention to the rapidity of progress of this disaster than the two maps given on p. 11 of this book showing the status of wildlife in Bihar at the beginning of the Century and now. Seeing the maps one wonders if there is any chance of survival for wildlife at all knowing the pressures of ever increasing human needs that these remnant habitats and their fauna face daily. These pressures are well expressed in the chapter on National Parks where the author narrates the difficulties that administrators have with their political heads, the ministers. Forest lands are perhaps the easiest largesse that a minister can distribute.

The author during his long service with the Bihar Forest Department had the opportunity to observe and learn about the wildlife of his State. The book provides ample evidence of his knowledge of Bihar's wildlife. Two chapters are particularly interesting. The history of the Mirshikars of Bihar, professional animal trappers, relicts of a once flourishing profession, bound to disappear with the vanishing wildlife. The Bombay Natural History Society had used them in its bird banding programme and found them to be amazingly good field naturalists. The second chapter which impressed was the one on the wolf, the grey ghost of the Indian plains, a ghost that has been truly laid over most areas of its past distribution. The animal has almost become extinct and yet we know so little about it.

The only complaint one has about the book is the format which is also responsible for high production costs putting it well beyond the purse of those for whom it has been written. The publisher has been prodigal with space and the pages have needlessly increased in number. The colour reproduction could also have been better.

A second edition, when published, could perhaps, be better organised. A book worth recommending to all educational institutions, libraries, in India and elsewhere.

J. C. DANIEL

4. BIRDS OF PREY. Their Biology and Ecology. By Leslie Brown. pp. 256 (24 × 17 cm), with many coloured and black-and-white photographs. London, 1976. The Hamlyn Publishing Group Limited. U.K. Price £ 4.50.

Leslie Brown's Book on Birds of Prey is the most modern comprehensive book on the subject. The author has spent all his life in the study of Raptors and this excellent volume is the culmination of his deep study on the subject. The book covers in detail classification, zoo-geographical distribution, habitats, anatomy, hunting methods, migration and covers breeding biology, ecology, predation, conservation and protection, in all their aspects. There is complete bibliography and an index comprising all birds of prey. There are appendices giving various habitats and mentioning categorically rare,

threatened and uncommon species relevant to their distribution.

The book gives diagrams of adaptations of tail, wing, bill, size, eyes and feet of birds of prey according to their flying and feeding habits and also showing territorial movements in flight. On page 109 a sketch shows the use of the double-jointed leg of the Harrier Hawk as adapted for catching its prey in crevices; many such typical illustrations are given.

The book is full of sketches, coloured and B & W photographs but these are not particularly for identification but to depict the birds main adaptive features and behaviour which also helps identification. On page 67, Leslie Brown points out that the highest known densities of birds of prey in world towns have been noted in New Delhi, India, with breeding territories of an average of 19.3 pairs per sq. kilometre, mostly of Black Kites and Vultures. According to the reviewer's studies, this gives a wrong impression of the Raptors in Western India, where birds of prey have crashed to very low levels and common resident birds of prey are not seen in half the numbers as in the past. The author mentions the effect of pesticides on page 226 and says: "—it is now generally accepted as proven by most reasonable people that certain organichlorine pesticides cause certain raptors, notably Ospreys, sea-eagles, falcons and accipiters, to lay thin-shelled, easily broken eggs so that the normal reproductive biology of the species collapses and it becomes locally extinct." He mentions the species so affected in parts of U.S.A. and Great Britain. He also mentions that the more toxic pesticides are being withdrawn from developed countries and that D.D.T. is outlawed in many.

The author wisely uses the general English names of birds of prey as they have been widely known and gives scientific names where necessary. When Leslie Brown mentions the Hen Harrier he means the Hen Harrier, and where the same bird is mentioned by another English name as in U.S.A., he puts it in perenthesis i.e. Hen Harrier (Marsh Hawk). Much credit must be given to the author for not coining his own names for Raptors which most modern ornithologists revel in resulting in confusing the reader. I know of no book on Raptors which gives so much scientific information on the subject and anyone truly interested in birds of prey should read it and to understand it read it over again and again. Doubtless, it takes some time to digest the matter as it covers World Species. In systematic changes the author suggests lumping *Aegypius, Torgos, Sarcogyps* and *Trigonoceps* to be merged with *Aegypius* and to have *Lophaetus* included in *Spizaetus,* as envisaged by Amadon. It is not clear whether our Crested Honey Buzzard (*Pernis ptilorhyncus* (Temminck) comes under or synonymous as *Pernis apivorus* as mentioned in the treatise. On page 140, paragraph 2, the author mentions as follows: 'In India and tropical Asia permanently resident races or related species occur'. If our species is referred to as related species then it is not mentioned in the book.

The author has had vast experience with birds of prey since his boyhood in India, Scotland and other parts of the world and finally in East Africa, and his profound interest in Raptors of the world has placed him on a high pedestal amongst experts.

On pages 54 and 211, photographs in black-and-white of the Whitebacked Vultures are shown. The birds appear to be those of the African Whitebacked Vulture which differs from the Indian Whitebacked Vulture in being lighter on the lower parts and upperparts; the birds seen in the pictures much resemble

the Longbilled Vulture seen in India. The author could have mentioned in the photographs that the birds are African Whitebacked Vultures.

If one wants to know all about birds of prey, this is the book and I have no hesitation to repeat that one can keep on reading it over and over again to digest the facts in one consolidated volume about birds of prey and their evolutionary trends since ancient times.

All naturalists interested in Raptors should have this excellent book in their collection and any library without it is missing an important book of world importance.

M. K. DHARMAKUMARSINHJI

5. THE MAMMALS OF PAKISTAN. By T. J. Roberts. pp. xxvi + 362 (30 × 21 cm). With 95 species illustrations, 90 text-figures, 118 distribution maps and four colour plates. London, 1977. Ernest Benn Limited. Price £ 35.00 net (in U.K. only).

In the consideration of its fauna the subcontinent of India has been so far treated as a whole. The MAMMALS OF PAKISTAN is the first publication based on political boundaries. In this case the political boundaries also represent the transitional zone between the Palaearctic and Oriental zoogeographical regions.

This is indeed a definitive treatise and one of the best books written on Mammals of the Indian sub-continent. The 158 species recorded from Pakistan are described in detail with a key for identification, taxonomical notes, description of morphology, distribution and status, and detailed notes on biology covering all available information on the species.

It is disheartening to note that the destruction of habitats and wildlife so noticeable in India occurs at an accelerated pace in Pakistan and more species are in a parlous state in that country than in India. The larger mammals have fared disastrously. One need quote only a few examples of the authors' remarks on the status of some species to illustrate this point.

Hog Deer Once plentiful throughout the riverain tracts of Sind and the Punjab, it now faces inevitable extinction within Pakistan territory unless special reserves are created for its preservation. Their considerable decline even within the past ten or fifteen years has been rapid and is due as much to a shrinking of their natural habitat as to hunting pressure!

Goral Unless Goral are totally protected, especially in Southern Swat region, they are not likely to survive another decade in Pakistan. Despite having a wider distribution than the Barking Deer, they are much rarer than the latter in the Margalla hills. Almost all the animals which are the target of hunters have reached the stage of requiring urgent attention for their conservation.

The authors' remarks on the state of the environment in Pakistan could equally well apply to any other country in South-East Asia. The population of Pakistan increased by 51.33 per cent between the censuses of 1960 and 1973 and showed an annual high growth rate of 3.7 per cent. The impact on the environment has been disastrous. I quote "Demand for fuel-wood resources from the scanty vegetation in Baluchistan and the North West Frontier Province has already led to total

denudation of many hillsides which were formerly clothed with scattered scrub forest. This has aggravated erosion problems which in turn reduces the efficacy of the ground water recharging cycle. Since these changes are having a profound influence on the mammalian population, besides limiting future resource use and availability for human needs, it is sincerely hoped that more careful long range planning and consideration will be given to this overall problem of resource exploitation. Reference to many of the books written about this region at the turn of the century corroborates the evidence of profound change. The foothills a few miles northwest of Peshawar were then thickly covered with forests and wild olive, in which the Asiatic wild sheep (*Ovis orientalis*), the Markhor wild goat (*Capra falconeri*), and the Chinkara gazelle (*Gazella gazella*) roamed. They could be within one day's horseback ride from Peshawar town (Warburton 1898). Today these hills are devoid of a single bush taller than 1 m. and there are no Chinkara or Urial even within a day's car journey from Peshawar, though a very few Markhor survive on some relatively precipitous mountains peaks."

The writing on the wall is written in big bold letters but as far as conservation of natural resources is concerned most people, particularly those in authority, are illiterate.

This is an excellently produced book but unfortunately priced for an affluent Society. Those who need to read it are not members of that Society.

J. C. DANIEL

MISCELLANEOUS NOTES

1. REACTION OF LANGUR, *PRESBYTIS ENTELLUS* TO A SNAKE

In Jodhpur, Western Rajasthan, there are no large predator of the Hanuman Langur, *Presbytis entellus entellus* Dufresne. It is of interest to record that snakes produce a panic reaction in Langurs. No case of such reaction appears to have been reported so far.

On the afternoon of the 23rd November, 1975, during routine behavioural observations at Vidhyasal, Jodhpur, I suddenly noticed that some adult females, juvenile and older infants of a group were standing in a circle screeching and looking intently at the ground. On investigation, I saw that they were peering at a foot long, moderately thick snake. As the snake moved slowly the langurs peered, shuffled and screeched loudly, and adult females sometimes ground-slapped. The younger infants also peered at the snake but did not screech. None of the langur, went close to the snake or touched it. Other members of the group, including the leader, came and looked at the snake for a moment and went away. The leader and three other adult males did not screech. After about eight minutes, I killed the snake while the langurs looked on silently. They remained there until the snake died and was motionless; and then went away one by one.

Other langurs, not present during the killing also came one by one, looked at the dead snake, and went away.

Next day I took the dead snake to the same ground, tied with a thread and threw some groundnuts around it. The langurs came and started eating the nuts, but as soon as they detected the snake, they stopped feeding, retreated at once and screeched. When I moved the snake by pulling the thread ,the screeching became louder. After a time, the langurs circumspectly took the nuts lying about a foot from the snake. The leader male did not screech as before but avoided approaching the snake.

The experiment was repeated on two other bisexual-single male groups, and in all cases, the reactions were as stated above.

S. C. MAKWANA

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May 30, 1977.

2. BIRTH AND GROWTH OF COMMON PALM CIVET (*PARADOXURUS HERMAPHRODITUS*) IN CAPTIVITY

A pair of Common Palm Civets (*Paradoxurus hermaphroditus*) are housed in an enclosure measuring 4.1 x 3.4 x 1.7 m at the Nandankanan, Biological Park, Orissa. Two wooden sleeping boxes measuring 0.6 x 0.3 x 0.2 m have been provided. They are fed with minced meat, fish, snail flesh, banana, milk and boiled rice.

The female of this pair gave birth to three young (one female and two males) in one litter on 30.4.1975. The young were fully furred and were able to produce a kind of feeble noise when handled within a few hours after birth. Their eyes were closed at birth and opened on the 8th day (male), 10th day (female) and 11th day (male). At birth, the three young weighed 92 to 98 grammes and measured 28.5 to 30.5 cm from tip to tip including tail lengths of 12 to 13 cm. The mother weighed 2.975 kg and the male weighed 3.985 kg on 1.5.1975. Weekly growth records of the three young were maintained up-to the age of 11 months and an abstract of the same is given below:

At the age of 11 months the three young apparently looked as large as the present.

Acharjyo & Tripathy (1974) have given the weight at birth of three males as 69 to 102 gm and length from tip to tip as 28 to 30 cm including tail lengths of 11 to 13 cm. They further stated that one young male weighed 995 gm. at the age of 3 months. The young of this species open their eyes in six to ten days (Acharjyo & Misra 1973). The age at which the civets become fully adult is not known (Prater 1971).

Date	Age in weeks	Weight in Kg,		
		Female	Male	Male
30.iv.1975	At birth	0.098	0.092	0.093
14.v.1975	2	0.227	0.244	0.248
28.v.1975	4	0.390	0.417	0.400
11.vi.1975	6	0.475	0.520	0.510
25.vi.1975	8	0.725	0.750	0.725
9.vii.1975	10	0.865	0.880	0.895
23.vii.1975	12	1.008	0.970	1.020
6.viii.1975	14	1.198	1.067	1.187
20.viii.1975	16	1.240	1.120	1.280
3.ix.1975	18	1.225	1.000	1.260
17.ix.1975	20	1.465	1.235	1.545
1.x.1975	22	1.658	1.430	1.592
15.x.1975	24	1.455	1.480	1.587
29.x.1975	26	1.420	1.680	1.560
12.xi.1975	28	1.480	1.805	1.780
26.xi.1975	30	1.652	1.880	1.970
10.xii.1975	32	1.605	1.800	1.940
24.xii.1975	34	1.880	2.010	2.250
7.i.1976	36	2.005	2.200	2.485
21.i.1976	38	2.190	2.280	2.525
4.ii.1976	40	2.555	2.295	2.550
18.ii.1976	42	2.265	2.285	2.540
3.iii.1976	44	2.265	2.305	2.520
17.iii.1976	46	2.280	2.325	2.560
31.iii.1976	48 (11 months)	2.505	2.380	2.585

ACKNOWLEDGEMENTS

We are grateful to Sri S. Jee, I.F.S., Chief Conservator of Forests, Orissa and to Sri G. M. Das, I.F.S., Chief Wild Life Warden, Orissa for providing facilities for observations.

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3. OBSERVATIONS ON THE ECOLOGY AND STATUS OF THE HISPID HARE IN RAJAGARH FOREST, DARRANG DISTRICT, ASSAM, IN 1975 AND 1976

(*With a text-figure*)

The Hispid Hare, also called the Assam Rabbit, *Caprolagus hispidus* (Pearson) (Lagomorpha : Leporidae), is more or less of the same body-size as that of the Common Hare. It is, however, distinguished by its coarser, bristly fur, dorsally dark brown in colour due to a mixture of black and brown hairs, ventrally brown up to chest and whitish on the abdomen, ear shorter than the skull and brown outside throughout, tail brown above and below and equal to or slightly shorter than the ear; hindleg short, but slightly longer than the forelegs.

The population of this interesting hare appears to have declined drastically in recent years. At present it is said to be found along the foot of the Himalayas in a few isolated places from Uttar Pradesh to Assam. Till 1951 it has been recorded only from Kheri in Uttar Pradesh, and a few spots in Goalpara and Darrang Districts in Assam. However, on the basis of the latest report of its capture in Rajagarh Forest Reserve under Baranadi Forest Range, Mangaldai Sub-division, Darrang District, by J. C. Mallinson in 1971 (*J. Bombay nat. Hist. Soc. 68* : 443-444), I visited the area in June 1975 and January 1976, to study the ecology and status of the Hispid Hare there. The survey was also conducted around Dharamjuli Tea Estate, Dimakushi,

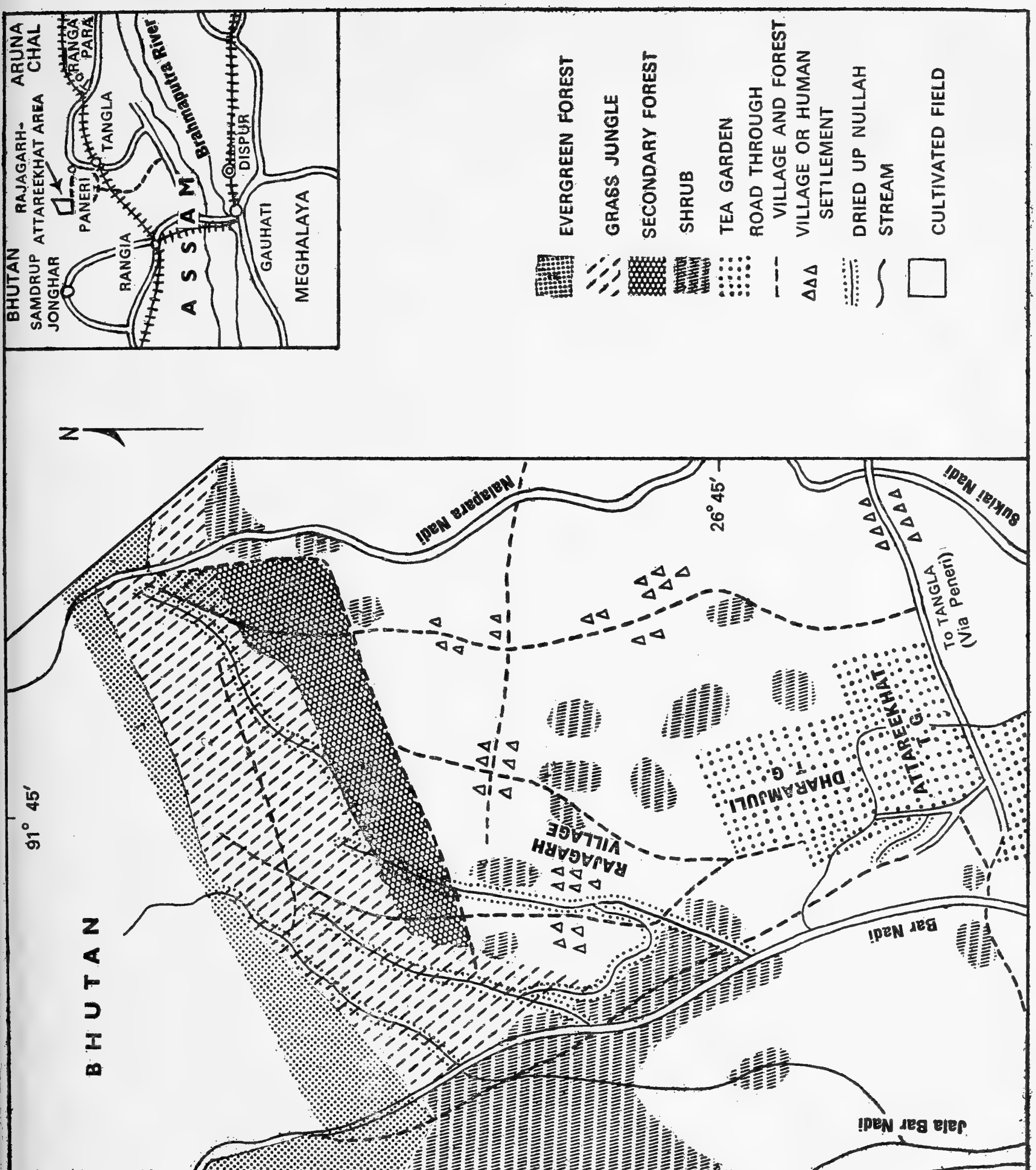

Fig. 1. Sketch map showing general topography of Rajagarh—Attareekhat area.

Nonai Forest Range, Majuli, Panery and from Bhutiachang to Kherkheria, all in Darrang District and about 3 to 45 km north and north-east of Attareekhat. From this survey and study it was evident that the Hispid is now found in the Rajagarh Forest Block, obviously due to its favourable ecological conditions.

Rajagarh lies about 5 km north of Attareekhat Tea Estate. This forest block includes the characteristic jungle and thatchlands of the Himalayan foothills, covering about 6-8 km east-west and 3-5 km north-south. The southern limit of the forest zone is bounded by secondary forest, consisting mostly of planted teak (Text-fig. 1). The thatch, typical grassland of the duars, grows up to about 3 to 3.5 metres height during the monsoon months and withers down to 1.5 to 2 metres during January to March. During our two visits, although the grass only stood about 1.5 metres tall, the animals could not be seen for the poor visibility in that habitat, but positive evidence of the presence of the Hispid Hare were obtained. However due to increased human settlement in the area, patches of forest and thatch are being cleared, thus upsetting the ecological requirements of the Hispid Hare.

The area is more or less flat but broken with very deep dried up 'nullahs' which are tributaries of the Bar Nadi or Nalapara Nadi. To the south of Rajagarh are a 2 to 3 km stretch of cultivated fields. Further south of this area are the tea gardens the Attareekhat and Dharamjuli Tea Estates.

The Hispid is a resident of the thatch and invades the southern cultivated fields occasionally for its favourite food. During January to April when the grass and the forest are set on fire, the Hispid moves to the cultivated fields, and shelters in tunnels and burrows on the embankments of 'nullahs'. Later, when the grass grows taller, it retreats to the thatchland where it is very difficult to locate. When the thatch becomes too waterlogged during the height of the monsoon, the Hare moves into the forested areas of the foothills. However, just before the monsoon when the thatch is burnt or when during the winter months the local settlers who collect the 'Borangamni Kher' (Assamese name for these grasses), one may sometimes come across the Hare. Also, the 'garo' tribals who customarily trap animals encounter this animal on many occasions and invariably use it for the pot. They rarely sell the hare in the market. Their hunting activities are secretly done without the knowledge of the forest officials.

The Hispid Hare, locally called as *Haha-pohu*, is not a very common animal at Rajagarh. On the contrary, the Rufous-tailed Hare, *Lepus nigricollis ruficaudatus* Geoffroy, is fairly common. This species, however, restricts itself in and around the cultivated fields and tea garden areas, and avoids the thatch. The Hispid, as reported by the locals, are slow-moving animals and do not dig burrows themselves. From the information gathered from the local 'shikaris', it appears that not more than 10 or 12 individuals of Hispid Hare have been caught during the last three or four years and their description of the animals—smaller ears, coarser coat, light brown as muga silk mixed with black, etc. tally well with that of the Hispid Hare. It is said that between January and March, young are usually caught. A pair of Hispids were said to have been raised from young from January 1975 by a 'shikari' at Rajagarh, but sold to a Cachari in Dimakushi Bazar in the last week of May 1975.

Besides occasional trapping and hunting by the local 'shikaries', it appear that carnivores like the Leopard-cat, *Felis bengalensis* Kerr, Large Indian Civet, *Viverra zibetha* Linnaeus, and the Small Indian Civet, *Viverricula indica*

(Desmarest), in the thatchland of Rajagarh have assisted in reducing the Hispid Hare population in the area. The village dogs are also said to prey upon this slow-moving animal at times.

The thatchland of Rajagarh offers protection to at least two threatened species, the Hispid Hare and the Pigmy Hog.

The following measures should be taken for their conservation:

(1) The habitat should be preserved by preventing further infiltration of human settlements, (2) all hunting should be prohibited, (3) the thatchland should be protected from forest fire, and the seasonal collection of 'Borangamni Kher', banned (6) efforts should be made to educate the local people on the value of the two species.

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4. BLACKBUCK (*ANTILOPE CERVICAPRA* LINN.) AT POINT CALIMERE

Introduction

One of the largest remaining populations of *Antilope cervicapra* Linn. is at the Point Calimere Sanctuary in Tamil Nadu. Daniel (1967) estimated the population of blackbuck at 750. Nair (1976) made a survey in 1974 and estimated the population at 340. These authors may also be referred to for habitat description etc. At the beginning of 1977 there were newspaper reports that the blackbuck were dying in large numbers. The officials of the forest department undertook a census in early 1977 and estimated the number of blackbuck at around 1500, and with this reassuring figure, the forest department allayed the fears of conservationists.

A census of the blackbuck was however undertaken by members of the Wildlife Conservation Society, Tiruchirapalli from 26th to 29th May 1977.

Blackbuck census

Most of the blackbuck live in the coastal strip of the sanctuary, and only a few were noted inside the reserve forest. The census party of 15 members was divided into 5 groups, each equipped with a pair of binoculars. The total direct visual count method was adopted. Three groups were deployed in the southern part of the sanctuary and the remaining two groups in the eastern part of the sanctuary. Every group started from the base line namely, the sea and proceed landward counting the animals present on their rightside only. In enumerating the animals the following classification was followed: Adult males, Subadult males, Females and Fawns. A total of 506 animals were counted, (Table 1) distributed in 38 herds. The herd size varied from 1 (made up of a lone male) to a maximum of 49. There were three bachelor clubs consisting entirely of males numbering 3 to 7. 16.4% of the population was male; and 11.3% was adult male. 401 or 79.2% of the total population were females. The sex ratio is 1 male for 5 females.

Biotic disturbances

About 600 domestic cattle (cows and buffaloes) were found grazing side by side with

the antelopes. Though there is a move on the part of the forest department to stop issuing grazing permits, grazing cannot be completely ruled out till the temple lands and the village forest are also acquired by the forest department.

The animals did not allow the enumerators to approach them, keeping a flight distance of nearly 200-300 yards. This is in strange contrast to the observation of Daniel (1967) that "There was no movement from the depth of one counting sector into the next mainly due to the fact that the animals showed little fear of man". The high flight distance maintained by the antelopes shows that there is poaching going on and that the animals have learnt to keep out of rifle range from man. Daniel (1967) had observed a greater percentage of males, the sex ratio being 1:2. But at present the number of males is much lower, the sex ratio being 1:5. This reduction in the number of males also indicates that poaching is going on, the males being preferred by the poachers. In spite of the fact that lopping is prohibited, the enumerators met on every day of their work in the sanctuary a number of women cutting and carrying firewood from the sanctuary. This human movement is quite likely to disturb the antelopes. There are also a number of jackals and wild pigs roaming the forest. The jackals are the main predators of blackbuck, devouring the very young fawns.

Acknowledgements

Our sincere thanks are due to Sri V. M. Narasimhan, Wild Life Warden, Madras who gave all facilities of the survey. Thanks are due to members of Wild Life Conservation Society, Tiruchirapalli, who participated in the Survey.

Table 1

Showing the number of herds sighted and their composition

Group	Adult male	Sub adult male	Female	Fawn	Total
I	1	2	4	—	7
	4	—	8	—	12
	3	1	22	—	26
	4	—	33	1	38
	2	1	31	1	35
	4	—	45	—	49
	1	—	3	—	4
II	3	—	—	—	3
	—	1	6	—	7
	—	—	4	—	4
	—	—	9	—	9
	1	—	1	1	3
III	1	—	26	—	27
	1	—	—	—	1
	2	—	8	—	10
	1	6	—	—	7
	1	—	1	—	2
	—	—	1	—	1
	—	—	9	—	9
	1	—	—	—	1
	1	—	6	2	9
	1	—	38	7	46
	—	—	2	—	2
	3	—	2	—	5
IV	1	—	3	—	4
	1	1	15	—	17
	—	2	13	—	15
	3	—	—	—	3
	—	—	17	—	17
	1	—	3	—	4
V	1	—	—	—	1
	2	—	46	2	50
	2	—	1	2	5
	2	—	18	2	22
	3	—	29	4	36
	1	—	1	—	2

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5. A WILDBOAR (*SUS SCROFA*) SHARING WILDDOGS' (*CUON ALPINUS*) KILL

On 10.vi.1977 while going along a game track watching for wilddogs at 0635 hrs. I saw a chital stag with 40-45 cm long horns in velvet running past me followed by a dhole. Before I could get into a cover the dhole saw me and abruptly stopped. Meanwhile I heard a sambar fawn being killed by the rest of the pack inside the nearby scrub. While I was searching for the kill the wild dogs smelt and saw me, growled and ran away. I retreated back climbed a tree and waited for the pack to return.

The pack which I was studying then had 8 adults and 8 six month old pups and I could hear the loud squeaking of the pups, audible even at a distance of 200 metres, from the nearby cover. At 0705 hrs one dhole went to the kill and by 0716 hrs the entire pack was eating. The scrub was dense and from my perch, which was nearly 50 metres away from the kill, only occasionally was I able to see the dogs eating. The fawn, being a small one, was soon torn into pieces and I could hear the dogs feeding within a radius of 20-30 metres.

At 0740 hrs I saw 3 dogs growling and running away. Worried and irritated that some local villager had come to take away the kill I was about to get down when I saw a medium-sized wild boar with its mane raised, grunting and walking amidst the dogs. The wild boar is a good scavenger on kill remains but I was surprised to see it among the wilddogs.

Here was an instance in which a wildpig, a prey animal of the wilddog, had shared the kill, a fact I verified later while searching for the jaw of the fawn. The sambar fawn could have provided each dog with hardly 1 kg meat and this is very little when compared to the

amount of meat each dog gorges (2.5-3.5 kg) while feeding on a full grown chital or a big sambar fawn. So tolerating a prey species to walk around and allowing it to eat at the kill particularly when the kill was insufficient for all members are worth recording. In the same area on 9.vii.77 Keechanna, my tribal assistant, saw a chital stag in velvet spikes being killed by the pack. He waited till the dogs finished eating and when he was about to go to the kill remains to weigh them and collect the lower jaw, he saw a wild boar making its way through the scrub towards the kill. The dogs returning from the kill circled around the boar for some time and then moved away. These, observations may suggest that once the 'killing or hunting effort' of the wild dog was over the prey animals may be immune to the wild dogs' predation for quite some time.

Earlier reports record jackals and Hyenas being ignored (Davidar 1975) probably by the existence of a 'blood-brotherhood bar' as Brander (1931) puts it. R. C. Morris (as reported in Burton 1940) has observed a pack of wild dogs, obviously well-fed, lying about on a grass hill-top while sambar walked, tails stiffly erect, right up to them. Apart from eyeing the deer lazily the dogs did not stir. On the evening of 2.viii.77 I saw an alarmed yearling sambar doe walk past through a single file of 4 dogs, part of the pack of 15, which 10 minutes later killed a prime adult chital doe. Earlier that day in the morning the pack had killed a prime adult chital stag with 38 cm long hard antlers but tribals took away the kill before the dogs could consume it fully. The pack, being 15 in number, was sufficiently strong to kill the sambar. Yet they preferred and killed a smaller possibly an already weakened animal. All these indicate that wilddogs though they have the courage and capacity are not wanton killers.

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6. BIRD MIGRATION ACROSS THE HIMALAYAS

It would be an interesting and instructive exercise to have a collection made of all bird migration records across the Himalayas. We may possibly gain considerable insight into the role of the Himalayas as a barrier or otherwise to birds winging their way to and from temperate Asia.

Here are two observations by myself which might be worth recording:

In the summer of 1968, I was crossing the Rohtang Pass at the head of the Kulu Valley (32/30°N, 72°E). May tends to be rather an unsettled month with sudden thunder storms gathering up on the snowy mountains. On the

morning of 24th May, we had started up for the pass in clear weather but by 3 p.m., the time we approached the crest of the pass, clouds had gathered and it began to snow. As we were plodding along the level top of the pass I heard a swish of wings and low over me a flock of more than a score of Swifts *Apus apus* swept out of the vapours from the Kulu side and rushed on barely a few feet above the snow on into Lahoul.

Again, in May of 1972,—unfortunately I do not have the exact date but it was in the third week—we had experienced foul weather for several days. I was walking up the Solang Nulla when a group of trainees from the Manali Mountaineering Institute met me on their way down. I was asked to identify a duck they had rescued on the scree near their base camp at app. 3350 metres at Bias Kund. It turned out to be a duck of the Common Teal *Anas crecca*. She had apparently been forced down by the storm as she, perhaps, with others of a flock was attempting to cross the Rohtang range. Though her flight feathers were badly worn, she looked in good shape. On my return to Manali I made enquiries about her fate but failed to gain any information. It is likely her migration ended in a duck curry.

The Kulu Valley has a north-south trend and at its head is the magnificent Rohtang range. The Rohtang Pass 3960 metres is the lowest part of the spectacular divide.

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7. A BUZZARD NEST IN LADAKH

Besides the not wholly unexpected small numbers of the Tibetan Crane that we saw in Ladakh, what struck the members of the World Wildlife Fund sponsored BNHS expedition to Ladakh in June-July 1976, was the comparative scarcity of birds of prey. An occasional European Kestrel and two sightings of Lammergeier were all there was to report till we reached the banks of the Indus at Dungti. Here, on the grassy banks we saw our first long-legged buzzard (*Buteo rufinus rufinus*). We met it again and again in the Hanlé Valley, in Hanlé village and in Puga which prompted Dr. Sálim Ali to quip that the bird was probably waiting for the writer's carcass!

In Puga (height 4880 m) we sighted not a loner but a pair of long-legged buzzard and it was not long before their nest was located, quite close to our camp on the ledge of a cliff. The nest was at a height of about 50 metres frrom the ground. The ledge on which it was built was quite inaccessible, there being big rocky overhangs just below and above it. The nest faced south while on the opposite side the ledge narrowed into a crevice in the rock that afforded a cool retreat to the birds from the heat of the sun. The nest was made up of Caragana twigs, grass tufts, cotton and wool rags, plastic-coated cable and pieces of manila rope, a liberal supply of man-made items being available in the Geological Survey camp down below.

As there was no place to put up a blind near the nest, we watched it from a convenient look-out ledge in the open, at a distance of

about 25 metres but approximately at the same level from the ground. As we could not hide ourselves the parent birds did not dare enter the nest, but on three occasions flew very near it in response to fervent calls from the juvenile occupying the nest. However, from the ground below one could see both the parents entering the nest by turn. One of them, probably the female (larger size), was a frequent visitor and had its favourite perch on a projecting rock about 30 metres above. The other bird was twice seen perched on the same ridge but almost a kilometre away from the nest.

A juvenile bird, probably two months old, occupied the nest. It appeared to be fully feathered and about 40 cm in height. Its head was creamy-buff, beak black, sharply hooked and with a lemon-yellow patch at the base. Feathers on the back were dark-brown and on the throat and breast dusty white with vertical brown streaks. Its tail was brown with white horizontal bars. The Tarsi were feathered, feet orange-yellow and talons black.

The parent bird that frequently came into the nest, was dark brown or chocolate in colour, lighter on head and breast and with a buff patch on the nape. Its beak was light yellow with a black tip.

On the morning of 19th July 1976, the nest was watched for about four hours. At first the juvenile was facing away from the observer and looked at him over its back. Then it turned and faced south. For a long time it looked around quietly from its high vantage point. It stretched its wings, spread out its tail-feathers, jerked its body and shuffled its feathers from time to time. Once it almost mounted over the edge of the nest to peer down the precipice. Then turning a full circle, its tail dangling beyond the edge of the nest, it defecated neatly over the edge and out in the air. From time to time it disappeared into the crevice to seek shelter from the sun.

For most of the time the parent bird was seen perched on its favourite rock above the nest. Once it rose on its wings, squealed and was airborne for almost forty-five minutes, calling from time to time. Its call sounded like a broad mew. Once it was gone for almost fifty minutes. During its absence the juvenile began calling. First it gave three short whistles and repeated the performance six times. It was probably thirsty for it stood panting with beak agape. When it saw the parent it called loudly and was twice rewarded with the former's close approach. The parent however, did not drop any food. Interestingly enough, house martins who had their nests on the same cliff about 10 metres below, constantly flitted about, sometimes coming very close to the edge of the nest. They showed little fear of the buzzards.

As noon approached the juvenile began calling more frequently. It was probably both thirsty and hungry. Soon thereafter observation was terminated as it appeared that the human presence was preventing the parent from entering the nest, thus prolonging the hardships of the youngster.

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8. RED-NECKED PHALAROPE IN SRI LANKA

The only published record of a phalarope in Sri Lanka (Phillips 1975) is of an injured Red-necked Phalarope, *Phalaropus lobatus* (Linnaeus), observed in a wet paddy field at Koppai near Jaffna at the north end of the island, on 1st January, 1944 (Henry 1971: 296).

On 5 March 1977 accompanied by Dr. S. W. Wignarajah of the Zoology Department Colombo Campus, we were watching flocks of waders on the salt pans at Hambantota, at about 1300 hrs, and saw a phalarope, conspicuously white with black markings, swimming in shallow water among Curlew Sandpipers, *Calidris testaceus* (Pallas), Little Stints *Calidris minutus* (Leisler), Marsh Sandpipers *Tringa stagnatilis* (Bechstein), Greenshanks *Tringa nebularia* (Gunnerus) and Ruffs *Philomachus pugnax* (Linnaeus). Eventually six of these phalaropes were seen—a group of five in one salt pan, and one in another nearby.

The birds were swimming in shallow water and only once did one emerge, briefly, on to a bund. On several occasions they were seen in flight, when they took off very readily with the (mainly) Curlew Sandpipers and Little Stints, which frequently flew short distances when slightly disturbed. The birds were not as tame as Henry's bird.

We had excellent views at ranges from 20-50 metres, in good light, using 10 x 50 binoculars. The association with other waders permitted a useful comparison of size, and the following descriptive notes were made.

"Conspicuously white with black markings; swimming in shallow water; smaller than Curlew Sandpiper, but larger than Little Stint; head white, with rather broad dark stripe through the eye, and extending only slightly behind eye; bill black, not longer than head, and not obviously thin; at rest conspicuous black bars on wing; legs black; greyish mottling on sides of lower breast. In flight upper surface of wing very dark with conspicuous broad white stripe extending the length of the wing; upper surface equally dark in front and behind the white stripe".

This description, particularly the black bill and legs indicates the Rednecked Phalarope; the closely similar Grey Phalarope *Phalaropus fulicarius* (Linnaeus) is difficult to distinguish in 'winter' plumage, but has yellow or yellowish bill and legs (Salim Ali & Ripley 1969: 322-325). Rednecked Phalaropes are known to winter in the north-west Indian Ocean and have been recorded on and near the western coast of peninsular India.

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9. UNUSUAL ORNITHOLOGICAL RECORDS FOR PAKISTAN

Chlidonias leucoptera (Temminck) White-winged Black Tern

HANDBOOK (Volume 3) indicates that there is an eastern population which occasionally wanders down to the east coast of India being recorded in Assam, Sylhet and Ceylon. There are only three definite records for the western seaboard from Bombay and Saurashtra.

On May 1st 1977, I visited Haleji Reservoir, an artificial lake some forty-five miles north of Karachi. The approximately three square mile lake is surrounded by an artificial embankment on the outside of which are many reed and tamarisk-fringed seepage pools. It is a rich wintering ground for Anatidae (twelve species can be seen in a day), besides having breeding colonies of Purple and Night Herons and Little Egrets. It has been declared a sanctuary since 1970. On one of these seepage pools there was a group of Whiskered Terns, *Chlidonias hybrida* hunting in repeated upwind sorties in typical fashion. I was at once attracted by a very brightly contrasted Black and White Tern amongst this group and to my delight found three Whitewinged Black Terns in full breeding plumage hunting over the same stretch of water. They were slightly larger than the Whiskered Terns and their all black underwing coverts besides jet black back and scapulars made them easily separable and distinctive from the Whiskered Terns. My impression in the bright sunlight was that their bills were black without any red. Their calls were more high pitched and less grating than those of the Whiskered Terns.

In 1970 on March 21st, a visiting French ornithologist, Jacqueus Vieillard now on the staff of the Paris Museum, visited Manchar Lake in Sind and thought he saw some White-winged Black Terns amongst Whiskered Terns. Though he was familiar with this species from North African ornithological surveys, while staying at my home in the Punjab subsequently, I rather arrogantly convinced him that he must have been mistaken especially as the birds were still only partly moulted into breeding dress. I must now record my apologies for what was almost certainly Monsieur Vieillard's record of the first recorded occurrence of this species in Pakistan.

Corvus corono sharpii Oates—Eastern Hooded Crow

An adult male specimen was noticed on the first day of 1976, frequenting some buffalo stables which I daily pass on the way to work, some twelve miles on the western outskirts of Karachi city in an arid desert area with scattered *Prosopis juliflora* scrub. The bird was generally in the company of House Crows (*Corvus splendens*) and attracted my attention by its paler grey breast and mantle, and then its noticeably larger size.

A specimen of the northern race, within

a few miles of the Arabian Sea coast, was obviously a most unusual straggler so on January 3rd I reluctantly decided to shoot it. The skin and its endo-parasites have been preserved and will be deposited in an appropriate Museum when opportunity allows. Measurements are: Total length 460 mm; wing 315 mm; tail 175 mm; tarsus 69 mm; culmen 50 mm. These measurements indicate a slightly smaller than average bird according to the range given in Stuart Baker (1922); (Wing 32-34 cm; tail about 20 cm; culmen 47 to 54 cm; tarsus about 55 cm and total length 48 cm).

My colleague Mrs. Ismat Parveen Anwar kindly examined the specimen for endoparasites and found about 50 adult males and 60 female Nematodes in its alimentary tract, identified as *Diplotriaena tricuspis* (Fedtsch 1874), which has already been recorded in the Asiatic population of *Corvus cornix* (synomym for *Corvus corone cornix*). Its blood stream also contained the larval micro-filaria of *Diplotriaena*. There were also ten female specimens of *Dispharynx spiralis*, syn: *D. nasuta* (Molin 1858).

A review of available literature indicates that the Hooded Crow occurs in two racial forms in neighbouring countries as well as inter-breeding with the Carrion Crow (*Corvus corone orientalis*). A very pale grey form (*Corvus corone capellanus*) breeds in southern Iraq and winters eastwards as far as the extreme south-west of Iran (Hüe & Etchecopar 1970). *Corvus corone sharpii*, which breeds throughout northern and central Iran, is considered only as a winter visitor to the north western regions of Afghanistan (Paludan 1959). Stuart Baker in the FAUNA OF BRITISH INDIA: (Birds, volume 1: 1922), cites Magrath and Whitehead, Army officers who were keen ornithologists and served before the first World War in these regions, for the evidence that the Carrion Crow (*Corvus corone orientalis*) was a regular winter visitor to Bannu and Kohat districts, but I do not know on what basis he claimed that *Corvus cornix sharpii* (syn: *Corvus corone sharpii*) occurs in winter in the north west Punjab. It is noteworthy that in Ripley's SYNOPSIS (1961) only the Carrion Crow, *Corvus corone orientalis*, is listed as occurring in the sub-continent, so there must have been some doubt as to the Hooded Crow observations. Salim Ali & Ripley in the HANDBOOK (Vol. 5, 1972), state that *Corvus corone sharpii* is a regular winter visitor to the North West Frontier Province, mentioning Peshawar, Mardan, Hazara, Bannu and Kohat.

Since there have been no reliable ornithological records or observations from these regions for the past 50 years, (neither Hugh Whistler nor H. Waite served outside of the Punjab), it is to be hoped that new studies can one day be made to find out the exact status of these crows. My own direct observations, supplemented by correspondence with bird watchers who have worked temporarily in these regions during the past ten or fifteen years, have corroborated that the Carrion Crow does still occur in winter around Bannu and Kohat being comparatively uncommon around Kohat. In the upper Kurram Valley (Para Chinar) it probably still breeds, as I saw one individual carrying a stick in its bill in mid-April. It is also reported to breed in the Takht-i-Suleiman Mountains on the border between Zhob and southern Waziristan. I have no reliable records of Mardan or Peshawar but the Jungle Crow (*Corvus macrorhynchos*) does straggle in winter down into the plains of Hazara as well as Mardan districts adjacent to the foothills and may account for sightings of Carrion Crows, recorded by Stuart

Baker (1922). In the field, silent birds of these two species cannot be separated though this would be possible by examination in the hand. Because of its similarity in coloration to the House Crow, the Hooded Crow could be overlooked, but so far I have failed to obtain any records even of possible sightings. Even an experienced ornithologist like Major Magrath believed that the Carrion Crow came into the Murree hills after the monsoon, which supposition is now known to have been mistaken (Whistler 1930).

Motacilla indica Gmelin—The Forest Wagtail

There are not many remnants of the original riverain forest left along the banks of the Indus river but an unspoiled block of about 5 square miles survives south of Sujawal bridge along the Indus river in the Thatta district of Southern Sind. (24° 10′ N., 67° 56′ E.). It comprises mainly *Acacia arabica* with a scattering of *Prosopis spicigera* and *Tamarix dioica,* on the higher land and the ground beneath is fairly bare of vegetation even in winter, being subject to annual inundation during the monsoon by upto 5 or 6 feet depth of silt-laden water. The avifauna of such forest is restricted, but tends to be rather unique and different from the surrounding cultivated areas or arid hilly tracts, and in December 12, 1976 I took two visiting ornithologist friends to visit this forest being certain of being able to show them Honey Buzzards (*Pernis ptilorhyncus*) and Red-breasted Flycatchers (*Muscicapa parva*) which would not be so readily encountered elsewhere in southern Sind.

The forest floor abounded with White Wagtails (*Motacilla alba*) and the occasional Sind Jungle Sparrow (*Passer pyrrhonotus*), but it was my friend Peter Conder (formerly President of the Royal Society for the Protection of Birds and a well known author) who drew our attention to a rather unusual pipit-like bird, which upon examination was found to be a Forest Wagtail. The third member, Bruce Amstutz, of the US Embassy, was also familiar with this bird from previous service in Burma. Apart from the clearly discernible double necklace of black and the two broad white wing bars, it was also distinctive in its habit of wagging its tail or rather lower body sideways instead of up and down in the manner of the surrounding White Wagtails. It was quite tame and allowed us to follow and watch it for some time. By chance I was able to visit the same forest with my family in December 27, and was amazed to encounter presumably the same Forest Wagtail within a hundred yards of the December 12 sighting.

This wagtail which breeds in south eastern Russia and China, is migratory in winter but normally visits only the southern part of India and Ceylon, and I have twice seen it in evergreen forest in Cox's Bazar, Bangladesh, where it was very tame. There is one record for Kutch (Ali & Ripley's HANDBOOK volume 9) where it was described as a straggler and I recollect that there is one very old skin in the Bombay Natural History Society collection labelled Karachi Sewage Farm which is attributed to this species.[1] Because this wagtail is not rare within its normal range in China and south eastern Russia, I decided to try and collect it the following week but a laborious search in the same region only revealed maddening numbers of White Wagtails. It is just possible that odd birds regularly turn up in these riverain forests and I shall certainly be on the lookout for it next winter.

[[1] There is an error here. We do not have specimens of *any* of the *Motacilla* from Karachi.—EDS]

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10. NOTES ON THE STRIATED BABBLER *TURDOIDES EARLEI* (BLYTH) NEAR DELHI

During 1973 and 1974 intermittent observations were made on a population of Striated Babblers *Turdoides earlei* in an area of reed-swamp (*Typha*) close to the Yamuna canal, south of Delhi. The area was visited on eleven occasions during February to May 1973 and twice in February and March 1974. The species was quite common in the vicinity of reed beds and also foraged frequently in nearby water meadows and arable land. Several groups were seen in January, in an adjacent area, feeding on dry fields and along bunds, but the species was not recorded in this habitat during the breeding season.

Four groups of Striated Babblers were located in 1973 within an area estimated as 0.24 km^2 in extent. Three groups were counted accurately and included eight, nine and ten birds; the fourth was estimated as containing five birds. The total population was therefore estimated as 32 birds and the density 133 birds per $km.^2$ The groups were not counted accurately in 1974, but four groups were agani present in the same area.

Nine nests were found in 1973 and two in 1974. Nest sites were of two types; either 1-2 m above the ground in a small palm tree (3 nests), tucked in at the base of the leaves, or 20-50 cm up in a dense clump of reeds (8 nests). The observed laying dates for first eggs were 27 February, 5 March and 9 April and two complete clutches were both of two eggs. Only two of the nests located in 1973 succeeded in fledging young and both of these were situated in reeds.

Because none of the birds were marked, it was not possible to tell how many group members participated in feeding the nestlings, but at both nests observed more than two birds took part. At one nest, containing young 5-7 days old, at least six adults were seen 'queuing' to deliver food to the nestlings, out

of a group of nine birds and it therefore seems likely that, as in the Jungle Babbler (Andrews & Naik 1970) all group members take some part in feeding the young. At both of the nests observed with nestlings adults took turns at maintaining a 'sentinel' watch close to the nest, the sentinel perching on a tall reed within a few metres of the nest. This position was swapped regularly after each bird had fed the nestlings.

Groups observed outside the breeding season usually fed together within a radius of 20-30 m. Some seen in January foraging in dry fields sometimes mixed with groups of Common Babblers *Turdoides caudatus* with which there was no obvious interaction. During the breeding season, however, birds were often seen foraging singly or in small parties and this also applied to members of a group which was feeding nestlings. Birds leaving the nest after bringing food would fly off in different directions and although none of the birds were marked it was clear that members of the group were feeding simultaneously over a wide area, constituting a large proportion of the group's home range.

During the early part of the breeding season, in February and March, one member of a group frequently gave a loud call "chirrup-ee, chirrup-ee-ee...", perched prominently on top of a tall reed. This usually continued for several minutes, being repeated after a short pause and similar calls from birds in neighbouring territories could sometimes be heard simultaneously. It seems likely that this call functioned as a territorial advertisement and if so it contrasts with the territorial calls of other species of *Turdoides* (*T. striatus, T. malcolmi, T. subrufous, T. affinis*) which are normally given by several group members in chorus (Gaston 1976).

Allo-feeding was observed several times in February. On each occasion the food was presented to a bird perched up on a reed stem apparently undertaking sentinel duty, by a bird which flew up to present the food and then returned to feed on the ground. Allo-feeding is a common occurrence among members of Arabian Babbler groups (Amotz Zahavi, pers. comm.), where presentations are also usually made to a sentinel. Zahavi considers that this behaviour plays a role in the communication of dominance status, but observations on this behaviour in the Striated Babbler were insufficient to provide evidence on this hypothesis.

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11. A BRIEF NOTE ON THE GRANDALA, *GRANDALA COELICOLOR* HODGS.

Both Whistler in "Birds of the Kangra District" and Mienertzhagen in "Birds Collected in Ladakh and Sikkim" when talking of the Grandala mention fast flight, a restless disposition and a predilection for settling on top of trees. My own observations bear out the fast flight and restless disposition but since on all occasions but one I have met the birds above tree-line, I have seen them only on the ground. Overhead they have a starling-like silhouette with triangular wings and a distinctly forked tail. In flight they often circle and glide very much like the Ashy Swallow-Shrike. On the ground, they hop about like chats but without the bobbing, have a very erect stance and continually flick the wings much in the manner a crow does. At this altitude—3500 to 3960 metres—they were feeding on insects—it is surprising how many winged insects, ladybird beetles and the like are wafted aloft on updrafts of warm air coming up from the valleys. I am convinced that quite a substantial amount of food is also procured in flight.

The one time I saw a huge flock of Grandala below tree-line was on the way to Badrinath (Garhwal) just above Hanuman *Chalti*. There were more than a hundred birds. Here also they were flighting on open hill slopes just above the Alakananda and though freely perching on midstream rocks I never saw them alight on some deodar nearby. The birds had been driven down by a very heavy fall of spring snow. All my other observations have been in the Kulu Himalayas.

The wonderful blue of the male is only apparent in proper light; on most occasions he looks black and is not a very arresting bird. The females are dark brown. In overhead flight a distinct light band shows along the base of her primaries.

The only call I recorded was a *klew .... klew .... klew*, which once heard is so characteristic as can always draw attention to a flock of Grandala in the neighbourhood.

All these observations were in the latter half of May.

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12. NOTES ON THE FOOD OF THE BLACKHEADED MUNIA AND THE SPOTTED MUNIA IN SOUTH KAMRUP DISTRICT, WESTERN ASSAM (INDIA)

In connection with studies on the ethology of the Common Weaver Bird or Baya [*Ploceus philippinus* (Linnaeus)], two other common ploceids namely the Eastern Blackheaded Munia [*Lonchura malacca atricapilla* (Vieillot)] and the Burmese Spotted Munia [*Lonchura punctulata subundulata* (Godwin-Austen)] were found in company with the Baya invading nurseries of paddy as well as the standing crop which was almost in preharvesting stage. The seeds sown in the nurseries attracted the ploceids greatly. These birds flocked

TABLE I

FOOD OF *Lonchura malacca atricapilla* (VIEILLOT)

Example No.	Sex	Date of collection	Locality	Feeding ground from which collection was obtained	Wt. of specimen (after killing)	Total wt. of stomach contents (sun dried)	Items of Food	Percentage	Remarks
1	♂	10-3-75	Rani, S. Kamrup, Assam	Flowering bamboo thickets and cultivated fields ground	14.5 gm	300 mg	Paddy (*Oryza sativa*) with fragments	78	
							Grits	22	
2	♀	-do-	-do-	-do-	15 gm	50 mg	Vegetable matter (bamboo seeds)	60	
							Grits	40	
3	♂	14-3-75	-do-	-do-	**14 gm**	**70 mg**	**Paddy** (*Oryza sativa*) with fragments, one undigested seed coat (grass)	28.57	
							Grits	71.43	
4	♂	-do-	-do-	-do-	14.5 gm	900 mg	Paddy (*Oryza sativa*) with fragments	93	
							Grits	7	
5	♂	-do-	-do-	-do-	14 gm	700 mg	Paddy (*Oryza sativa*) with fragments	92.86	
							Seed coats (bamboo seeds)	5.72	
							Insect fragments	0.71	Fragments beyond identification
							Grits	0.71	
6	♀	-do-	-do-	-do-	13.5 gm	350 mg	Paddy (*Oryza sativa*) with fragments	85.71	
							Insect fragments	11.43	Fragments beyond identification
							Grits	2.86	
7	♂	-do-	-do-	-do-	13.5 gm	340 mg	Paddy (*Oryza sativa*) with fragments	88.24	
							Grits	11.76	
8	♂	-do-	-do-	-do-	14.5 gm	160 mg	Paddy (*Oryza sativa*) with fragments	93.75	
							Grits	6.25	
9	♂	-do-	-do-	-do-	14 gm	60 mg	Vegetable fragments (bamboo seeds)	50	
							Grits	50	
10	♂	-do-	-do-	-do-	14.5 gm	60 mg	Vegetable fragments (bamboo seeds)	50	
							Grits	50	
11	♂	16-3-75	-do-	-do-	14.5 gm	100 mg	Paddy (*Oryza sativa*) with fragments	30	
							Grits	70	
12	♀	-do-	-do-	-do-	14 gm	90 mg	Paddy (*Oryza sativa*) with fragments	33	
							Grits	67	
13	♂	-do-	-do-	-do-	15 gm	270 mg	Paddy (*Oryza sativa*) with fragments	78	
							Grits	22	
14	♂	-do-	-do-	-do-	13.5 gm	100 mg	Vegetable matter (bamboo seeds)	20	
							Grits	80	

in hundreds from nearby sugarcane fields, bamboo thickets and tall grass growing in marshes.

The Eastern Blackheaded Munia is confined to Assam, Manipur and Bangladesh west to eastern Nepal, eastern and southern Bihar and northern Orissa, and the Burmese spotted Munia is distributed in Assam and Bangladesh in the plains and up to *c* 1800 metres. Both are resident species of western Assam, and are found moving in flocks from one area to another invading crop and grasses in flower. Mason and Maxwell-Lefroy (1912, pp. 123-124) stated that the Blackheaded Munia damages ripe paddy. They also examined the stomach-contents of three examples of the Spotted Munia. Out of these three birds, one took two injurious insects but all of them had taken weed seeds. They further remarked that this common species do some considerable damage to grain, especially paddy, but a large percentage of food in all probability consists of small weed-seeds and sometimes of insects. Whistler (1963, pp. 215-216) stated that the Spotted Munia feeds largely in low-seeding herbage. Ali & Ripley (1974, pp. 115-118) stated that the food of the Eastern Blackheaded Munia consists of grass-seeds and rice; and that of the Burmese Spotted Munia grass-seeds, rice, lantana berries, etc.

Some 14 examples of the Blackheaded Munia and two examples of the Spotted Munia were collected from Rani, Kamrup district, Western Assam in mid-March 1975. All the birds were in non-breeding condition. The collections were made from two different feeding grounds. One group was obtained from cultivated fields and the other from bamboo thickets. It was interesting to observe that since some of the bamboo was in flower, there was a large number of birds on these, presumably feeding on the bamboo-seeds which blossom and seed once

TABLE II

FOOD OF *Lonchura punctulata subundulata* (GODWIN-AUSTEN)

Example No.	Sex	Date of collection	Locality	Feeding ground from which collection was obtained	Wt. of specimen (after killing)	Total wt. of stomach contents (sun dried)	Items of Food	Percentage
1	♀	10-3-75	Rani, S. Kamrup, Assam	Flowering bamboo thickets and cultivated fields ground	15 gm	220 mg	Vegetable matter (bamboo seeds)	73
							Grits	27
2	♀	-do-	-do-	-do-	14 gm	230 mg	Paddy (*Oryza sativa*) with fragments	26.08
							Vegetable matter (bamboo seeds)	43.48
							Grits	30.44

in 20 years approximately. Birds taken in mist-nets or shot were immediately dissected, and the contents recovered from the crop and stomachs, were sun-dried. Analysis of the contents of the two species is given below in Table Nos. I & II.

From the above analysis, it appears that bulk of the food of the above two species of munias consists mainly of vegetative matters, (approximately 82 per cent), about 46 per cent consist of paddy and 36 per cent seeds of bamboo and other weed grasses. The remaining 17 per cent have been found to be grit and about one per cent only of animal matter.

The bayas and munias that concentrated in large numbers in a small area of one square kilometre approximately in Rani where this study was made, was estimated to have a population of 1000+ of each species of munias. It was observed that they congregated in large numbers on the nursery of paddy and caused a considerable damage to the paddy cultivation. The local cultivators drive away the birds from such affected nurseries and mature crop employing boys to pelt stones and beat drums. From the analysis of their crop and stomach-contents, it is evident that their first choice as food is grains of paddy.

It has been observed that the munias made 20 trips on average during the whole day from their roost of sugarcane and bamboo thickets to the nursery and standing crop of paddy. Each bird consumed about five grams of paddy in a day. When a flock of 2000+ munias were operating in an area of one square kilometre, the average loss as estimated was nearly five kilogrammes per day per species. This loss is quite substantial to the cultivators.

In conclusion it may be stated that both species, the Blackheaded Munia and the Spotted Munia are definitely harmful to cultivation and could be categorised as serious cereal pests in Western Assam.

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13. NOTE ON THE STATUS OF THE GIR CROCODILES

(*With a plate*)

The superintendent of Gir National Park, Sanat Chavan provided transport for me to visit Hiran Lake the morning after my arrival at Sasan Gir on 28 May 1975. Jeevan Lal, a maldhari (herder) who had assisted Paul Joslin's lion study, was my guide for the next few days. I spent the first day making a round of Hiran Lake, the reservoir formed by the Kamleshwar

Dam within the Park. Being a drought year the reservoir was down to two long channels about 30 metres wide and rarely more than 2 metres deep.

We saw 20 crocodiles (*C. palustris*) in the water during the day, none basking, ranging from last year hatchlings to adults upwards of 3 metres. The most interesting feature of the habitat was the presence of 16 tunnels in one high embankment, dug by the mugger apparently against the eventuality of the lake completely drying up. The tunnels had flattened oval entrances and averaged 80 cm in width and went in 4 to 5 metres. Using a torch we found that there was a crocodile in nearly every tunnel. In the vicinity of the tunnels Jeevan located a nest of crocodile eggs in the course gravelly soil *c* 3 m above the water line, by noting the disturbed nature of the nest site. Searching the vicinity we located another nest. Later, joined by Mr. Chavan, the eggs were carefully collected and packed in hatching boxes using the original nest soil. Each nest contained 25 eggs, indicating smaller females of 2 to $2\frac{1}{2}$ metres length

Just across a thin channel from the nest sites I stretched down over a steep ledge to peer into a tunnel with my torch. There was no need for a light however, an adult mugger's face peered at me from little more than an arm's length away. The crocodile made no movement and was in that position several hours later. We assumed this was perhaps one of the females whose nest had been found.

That night we made a complete circuit of the two channels that make up the Hiran Lake at this time of year. Using a powerful torch we counted the red glowing eyes of 51 crocodiles, estimated that we missed at least 25 for a total of 76 mugger of all sizes. This is the largest single concentration of mugger we know of in India. We spent almost the whole night at the dam and were treated to a spectacular lion chorus, something the unfortunate tourists at the Sasan rest house would never hear.

30*th May*: Jeevan Lal and I spent the day examining the Lake and parts of the Hiran River, below the dam. There was evidence of a few crocodiles in this densely wooded swampy area. We were told by one of the old Forest Guards that during fishing activities by the Fisheries Department, a number of crocodiles came down to the shelter of this swamp. Compared to the reservoir area, which is barren except for a few old tree stumps, this is ideal "alternate habitat' for juvenile crocodiles. We randomly examined crocodile feces and found remains of fish, cattle egret and watersnake. We spent the hot part of the day at the "ness" of a very hospitable family of Maldharis camped near the lake. They surround their camp with a large pile of thorny branches similar to the "boma" in parts of Africa. We had a long talk about crocodiles and they told us of the "jhurd", a tentacled beast that lived in deep water which pulled animals and men under water. The skin and bones of the unfortunate victim would be found several days later. A note on this "beast" is in *JBHNS* (27:175).

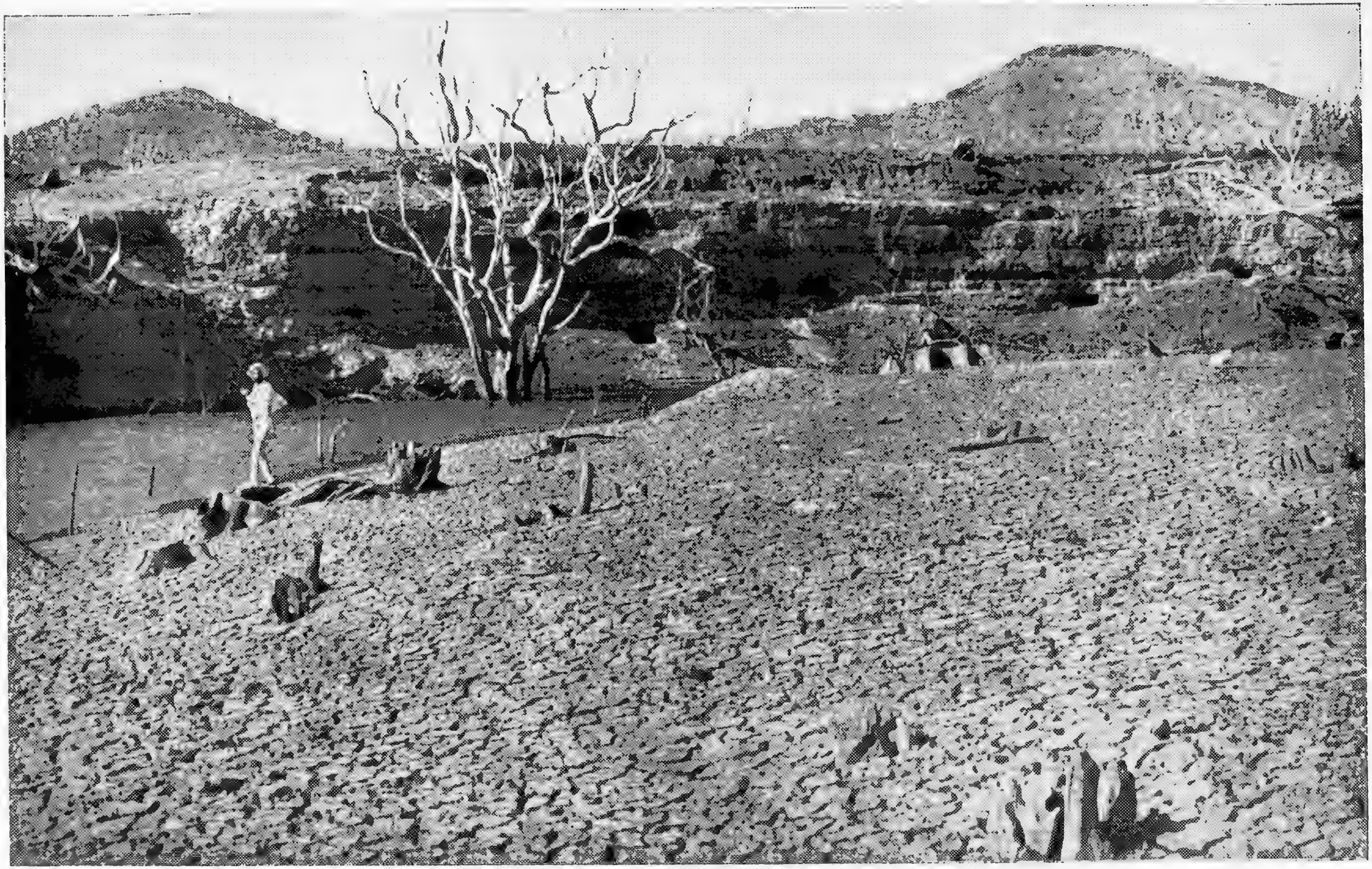
Later in the day we found a crocodile skull and were told of a group of "mugri puckard wala" who came "a few" years ago. 5 or 6 men with women and children camped at the lake and, using hooks baited with goat guts tied to heavy line floated with peacock feathers, caught about 15 crocodiles. The crocodiles were killed with an axe, the skin, fat and some parts removed. The hunters moved on after a few weeks. We later watched two crocodiles "trap" fish near the shore and one caught a large fish and ate it.

June 1st: we spent the day touring the National Park to see other crocodile habitat in the now mostly dry Hiran River and tributaries.

We passed through the villages of Seerwan and Madhupar of the "Sidhi-lok", Africans said to have been brought as warriors (slaves) by some of the old Rajas. They are practicing Moslems and now speak Gujarati. At Bonaj, a temple in the Park, we were told there are two crocodiles in the pool there and there we saw a tunnel in the embankment with fresh marks. We also visited Mugri Guna where there were several crocodile tunnels, one obviously occupied. These tunnels were generally dug under the shelter and support of the roots of a "jamun" tree (*Eugenia jambolana*). Sodia nullah, Pilipat Stream and Singoda Nadi are other spots which retain water in the dry season and have a few resident crocodiles. The Maharaj at Bonaj said that a crocodile was dug out of tunnel two years back at Mugri Guna by some "jungle people" not local. The crocodiles in these streams "gunas" must nest in the water—accumulated piles of sand. These areas are very disturbed by the daily arrival of hundreds to thousands of cattle. In the evening I caught a bat downed by crows. It turned out to be a Bearded Sheath-tailed Bat.

4th to 6th June was spent in the hospitality of Jamsahib of Jamnagar in the Barda Hills about 40 km from Porbandar. This is an area of about 200 sq. km of scrub jungle with hills up to 2,000 ft. These little hills and those in the Gir area are just about the only water shed/catchment areas left in the desert—like Saurashtra. There are numerous small and large tanks in the hills, several have small crocodile populations. Five of the larger minor reservoirs are Rana Sagar, Gulab Sagar, Suth Sagar, Phodara Sagar, Khambara Sagar.

South of Porbandar lives a group of about 4,000 people known as "Deemar." These are part time cultivators, hunters and fishermen. One of these, Jumma Ismail, was camped with his family at Khambara Sagar so I spent the night there talking and watching the fishing. Jumuna said that at least 50 crocodiles had left this reservoir since they started fishing, as the water went down. Now it was mostly a shallow lake with one area of deep water up to about 4 m. The migrant crocodiles were apparently headed toward a larger tank about 8 km away. Since this was the worst drought in 40 years, this years overland crocodile activity was unusual. Local hunter/gatherers, the Wagris, (taught by professional crocodile hunters said to travel around from U.P.) now know the value of crocodiles skin, fat and odd parts for "medicine." It is doubtful said Jumma, if any of the crocodiles made it to the next reservoir as he saw the Wagri follow up and kill a number of them. It was useless to try to spot the crocodiles at night he said, they know about night hunting and disappear. We saw crocodiles the next day only. Early in the morning we made a round of the lake and found the tracks of a sub-adult crocodile leading up into the scrub jungle hills; naturally we followed it. An expert shikari, Mesur, was along so we had little difficulty locating the slight scuff marks on the scorched packed soil. The crocodile mostly followed cow paths but also climbed up steep rocky faces with lizard efficiency. We finally found the animal about $2\frac{1}{2}$ km from the reservoir, half hidden under a large over-hanging rock which sheltered it for the day. It had about 6 km to go to reach Phodara Sagar and cow-herders were sure to spot it. With some difficulty we caught the metre and a half animal, tied its jaws with a binocular strap and took turns carrying it back. Later we released this and a juvenile Jumma had caught in his net into a reservoir not likely to dry out. At Khambara during the day we saw several juvenile crocodiles up to 60 cm long and one adult about 2 m. Jumma said the same U.P. catchers who had visited Gir a



Hiran Lake, Gir in drought season. Nearly every crocodile tunnel found here contained a crocodile. Two nests were located very close to this site.

few years back came here. He mentioned that crocodile gall bladder cures cataract. Other local "medicine" includes hyena fat for painful joints and grey hornbill flesh for women in labour. In the rainy and winter season, Jumma uses his fish nets for bird trapping.

Other crocodile habitat in Gujarat which should be surveyed by day and night for determining crocodile populations are:

a) Bhadar Dam near Gondal, Saurashtra
b) Machhu Dam near Wankaner
c) Shetmuji Dam near Palitana
d) Mahi River, Vanakbori Reservoir, Kira District
e) Mahi River, Kadana Reservoir, near Rajasthan border
f) Powaghat Hills, lake at 1,500 ft, near Baroda
g) Nagmati River, Ranjit Sagar, Jamnagar water supply.

This year (1975) Ranjit Sagar dried up for the first time in 40 years. Three crocodiles were caught and transferred by the municipality; another 25 to 30 were reportedly killed by Wagris, Polis and other people. There may have been no shooting during Lord Mahavira's anniversary year in Gujarat but the crocodile axe was most active.

Thanks are due to Sanat Chavan, Jeevan Lal and Jamsahib for all the help and kindness extended during my visit.

R. WHITAKER

MADRAS CROCODILE BANK,
MADRAS,
June 9, 1977.

14. NOTES ON VOCALIZATION AND PROTECTIVE BEHAVIOUR IN THE MUGGER

In 1972 at the Madras Park we had six 2 year old, metre long mugger (*Crocodylus palustris*) in an enclosure with a metre long salt water crocodile (*C. porosus*). Catching the latter for transporting to another enclosure, it gave the crocodilian distress cry which is apparently an amplified (high-pitched and open-mouthed) version of the typical grunts they make from the hatching stage onward when alarmed or in response to another crocodile grunting (grouping mechanism).

On hearing the salt water crocodile's distress cry the mugger unhesitatingly charged me as I was holding the crocodile. Only a quick jump over the wall saved my toes. Later we recorded the distress cry and the young mugger zealously attacked the recorder. I learned to mimic the juvenile distress cry and was able to observe interesting response by wild mugger in several habitats. In Corbett National Park, with D. Basu now of the U.P. Crocodilian Project, we "called" crocodiles at night at the big pool near Gairal R.H. One mugger almost 3 metres came slipping and stumbling out of the river over the round boulders at quite a good pace, white mouth wide open and reflecting the light. It stopped 5 metres short of us and seemed to smell us or think twice about this artificial distress cry. After a few minutes it returned to the water. We had heard there were crocodiles at Malani Tal in Corbett. To prove it I waited there till after dark then climbed one of the overhanging jamun trees and called. Two adult mugger of $2\frac{1}{2}$ to 3 m. swam to just below the tree. At Kilikudu Pond in Tamil Nadu, in the midnight company of several colleagues

we had seven wild crocodiles swimming toward us in response to a mimic distress cry when a medium sized mugger suddenly burst out of the bushes on the bank behind us and charged right past us, open mouthed. In the Gir at Hiran Lake, with Sanat Chavan, Park Warden we had a 3 metre mugger come out almost to our feet, again in response to the mimic juvenile distress cry. It only returned to the water when we tapped with a walking stick in front of its snout. In our experience mugger learn about this deception quickly and it would rarely work twice in the same place and sometimes not at all. It was especially dramatic in a new, fairly undisturbed population. In Sri Lanka last year, in the company of a Lanka herpetologist, R. Senanayake, we watched no less than 16 crocodiles approach us. Being in a low unprotected spot we hastily quit the area.

We have never heard mugger bellow as do alligators. Sometimes during threat displays (and mating) one or both participants will emit gargling growls, the inferior one (with upraised head in appeasement) usually ending in a typical crocodile grunt. The loudest sound we heard from a mugger was a wild caught female of just under 2 metres, caught in a net. Brought to shore and caught by the tail the crocodile emitted loud, deep distress cries with a tone similar to a calf's voice. The most typical mugger sounds are the grunts which the juveniles start using while still in the egg to communicate to the parent (and other eggs) their readiness to hatch.

MADRAS CROCODILE BANK,
MADRAS,
June 5, 1977.

R. WHITAKER
Z. WHITAKER

15. NOTES ON CAPTIVE BREEDING IN MUGGER (*CROCODYLUS PALUSTRIS*)

The 600 ft circumference breeding pond for mugger at the Madras Crocodile Bank holds approximately equal land and water area. The pond was dug to the water table and banks for basking were created with excavated sand. Clumps of pandanus and *Casuarina* and when necessary temporary palm leaf shelters provide shade. As far as possible, wild conditions have been simulated. In the rains the maximum water depth is 3 m and in the summer 1 m. Maximum and minimum air temperatures during the incubation period are 42°C and 28°C.

The enclosure supports 14 mugger; 8 females (3 adults) and 6 males (2 adults). Under normal circumstances this is a fairly compatible group and little serious fighting occurs.

1977 was the second successful breeding year and notes on nests and nesting behaviour are given below.

Nests and hatching:

Both at the Crocodile Bank and at the Snake Park (one pair of adults) mating commenced from mid January.

On the night of 20th February the 13 year old female at the Snake Park laid 10 eggs in her nest 20 cm under the (laterite) soil. The eggs were transferred to hatching boxes on 15th April, and 6 hatched on 16th May.

On the night of 3rd March a 15 year old female ("Alpha") at the Crocodile Bank breeding pond laid 28 eggs under 26 cm of sand in a *Casuarina* clump in the north-west corner of the enclosure. Sand had been thrown

off to first create a body pit to prevent the nest from filling up. Alpha entered the water at 7 a.m. the following morning closely attended by Beta, her mate (largest male) and Mett (second largest male). Mucous still hung from her cloaca and she seemed greatly fatigued, making only half hearted and feeble attempts to charge while the nest was being examined. The 28 eggs were transferred to hatching boxes on 28th April, and all hatched on 6th May.

On the night of 21st March a 7 year old female in her second laying year deposited 24 eggs, slightly to the north of Alpha's nest. The eggs were collected in hatching boxes on 9th May and only 3 hatched on 25 May.

A third undetected nest of 10 eggs was laid on the south bank by a first year layer. On 25th April an open nest hole was seen with 3 empty egg shells and 7 intact eggs. One juvenile was spotted in the pond and netted after considerable difficulty; during this exercise Mett and Alpha repeatedly charged us as we moved along the south bank. The juvenile, before it was noosed, swam slowly around Mett's jaws. There was no sign of the other two juveniles who were probably eaten, by a subadult. On 27th April the remaining 7 eggs were opened after candling and only one contained visible remains of a very young embryo. The eggs were not dessicated; they were either infertile or the embryos had died early from an unknown cause.

Mating behaviour:

Morning, evening and occasional nocturnal observations were made on Alpha (biggest female), Beta (biggest male) and Mett (second-largest male), during March.

Beta and Mett are the dominant males of this group. During the breeding season (January to June), they were constantly bullying sub-adult males, chasing them around the enclosure and biting them on the tail and back. Mett was very much second in command however and would often make submissive gestures (raising head to show underside of jaw) when basking or swimming near Beta.

Alpha and Beta commenced mating in mid January and mated regularly while Alpha was incubating her eggs. To give an idea of mating frequency, from 5th to 11th March mating was observed every day except one, in the morning (8 a.m. to 11 a.m.) or late evening (5.30-6 p.m.). Copulation lasted from 7 to 10 minutes.

After Alpha had nested, mating always occurred in the western end of the tank, below the nest. Prior to mounting, the male often bites water with a loud side-ways clap and hisses, sometimes swimming to the female with his back out of water but more often reaching her under water. Often Beta would grunt nasally before submerging; this display however could also be a threat (to other males) and not exclusively mating behaviour.

The following extract from our notes of 6th March describes the mating procedure. 8.05 a.m.—Alpha slides into water from nest, Beta on north bank. Beta swims, back slightly out of water, to Alpha rests with nose touching her tail. Alpha turns around, swims to west; Beta makes long, loud nasal grunt, follows, and mounts. Alpha submerges, Beta half submerged. Mett swims up from east of tank, circles mating pair, stops with head parallel to Beta's, rests head on Beta's back, after short submissive gesture. Mett submerges as Alpha and Beta submerge further. Alpha and Beta surface after ten minutes, still mating. Beta hisses, submerges again and surfaces, hissing. Beta rolls over and dismounts.

On two occasions Alpha was seen making what appeared to be a mating display, both times when Beta was at some distance and had not mated with her that day. She would roll

on her back, remain this for a few seconds, and roll over again. Her cloaca seemed slightly extruded and what were possibly the scent (musk) glands were momentarily visible.

Although Mett did not mate with Alpha (Alpha mated only with Beta) he enjoyed a special status. Alpha was intolerant of other crocodiles in the proximaty of her nest or in the corner of the tank below the nest, and Beta consistently chased out other males from the area, but Mett was tolerated by both and was allowed close proximity even while mating was going on. He was frequently to be seen basking not 6 ft. from Alpha's nest.

Beta also mated with another female while Alpha's eggs were being incubated. Prior to mating she was observed rubbing the underside of her jaw on his head, swimming around him in circles and once, when Beta ignored her advances, she blew out a terrific mass of water bubbles into the air.

Mating continued at least upto 4th June, when Beta grunted nasally before mounting Alpha. When Mett came over however Beta left Alpha, mounted Mett, and adopted the mating posture!

Temperatures and egg sizes:

TEMPERATURE RECORD FOR NEST 4 (SNAKE PARK)

(10 eggs—size range 7.2 × 3.8-8 × 4 mm. Average 7.5 x 4 mm)

Date	Surface			Egg Level		
	Morn.	Aft.	Eve.	Morn.	Aft.	Eve.
16/3	28	29	30	28.5	33	31
19/3	28	32	31	29	30	29
23/3	28.5	29	30	29	30	29
30/3	30	33	31	28	29	30
2/4	30	33	30	29	30	29
6/4	30	31	30	29.5	30	29.5
9/4	34.5	33	33	29.5	31.5	31.5
13/4	31	32	31	30	31	30
16/4	31	31.5	30	30	30	29.5
20/4	30	31	30	29	30	29
23/4	31	34	33	30	32	31

Protection of the nest:

Individual females vary considerably in nest protection. Shortly after laying her eggs, Alpha sustained an injury on her right hind foot which rendered the ascent to the nest a painful exercise. During this period she would not attempt coming up when nest temperatures were being taken, but toward the end of the incubation period when the leg was healed she would rush out of the water to the nest on sensing the slightest disturbance near it. She would usually charge open mouthed and belly flop on the nest. Crocodiles basking on the western bank near the nest were frequently chased and bitten. Alpha's daily routine was: Coming to the water (8 ft. below nest) at 7.30-8 a.m. and unless there was disturbance near the nest, returning to it only at 6-6.30 p.m. Nights were spent on the nest. Incubation and protection continued after the eggs were collected. On 10th May she chased a sub adult male basking near the nest halfway round the enclosure and bit him on the back and tail, while he repeatedly made submissive gestures. As late as 7th June, a month after the eggs had hatched, she chased RW an assistant out of the enclosure.

The other two nests did not enjoy such dedicated protection and the females were never observed chasing intruders. The nest to the north of Alphas' was often exceedingly wet in the mornings and the theory that a broody female urinates or evacuates water on her nest comes to mind. A wild mugger nest in Kedarhalla in 1975 had the same degree of wetness and Reuben David reports cloacal nest wetting at Ahmedabad Zoo.

Alpha did not feed during the entire incubation period, although rats, fish and frogs were

offered to her and there was always plenty of food in the tank. She was first seen to catch fish in the tank on 3rd May. About this time also, she started leaving the west end of the tank and venturing out into the open water expanse, with the other crocodiles.

The 13 year old female mugger at the Snake Park which laid on 20 February guarded her nest from a pool in the west corner of the enclosure. She made serious charges at intruders, followed by a furious chase which brought the man to the other side of the wall. (Alpha had been more inclined to reach her nest only, and belly flop on it). It is a matter for conjecture whether the intruder would be bitten if caught up with. W. T. Neill (LAST OF THE RULING REPTILES) doubts that the American Alligator bites in similar circumstances and there are no records of mugger actually biting in nest defence. However in Orissa there are two authentic records of gharial having done this.

After half the incubation period was over the Snake Park female suddenly directed her protective instincts to the southern corner of the enclosure, charging at any disturbance there and allowing the actual nest to be approached with impunity. As late as 20 May she rushed out open mouthed when this area was approached. This disorientation was perhaps caused by our forceful prevention of her access to the nest while humidity and temperature checks were being taken.

Male mugger have not thus far been reported to participate in nest protection. On two occassions during incubation, Beta was seen to stay in the water below the nest when Alpha took a short turn in the open tank. However this might be pure coincidence. But Mett's repeated lunges and attacks while the juvenile was being caught, and the male mugger's active response to the distress cry of the young are significant and indicate perhaps a higher degree of protective interest than we believe.

MADRAS CROCODILE BANK,
MADRAS,
July 4, 1977.

ZAHIDA WHITAKER
ROMULUS WHITAKER

16. GROWTH RATE OF *CROCODYLUS PALUSTRIS*

From June 1975, 71 hatchlings from wild collected and captive bred marsh crocodile nests were reared at the Madras Crocodile Bank. For the first three months they received live tadpoles, live small fish and chopped fish. The living tadpoles and fish were added to the rearing ponds to maintain a density suitable for easy capture. The finely chopped fish was put on large leaves at night to ensure that even hatchlings unsuccessful at catching live prey would feed. In addition a sixty watt light bulb was kept in the hatchling enclosures to attract insects at night. As seems to be true of most animal groups reared together, a few grow exceptionally rapidly, a few extremely slowly and the majority at an average rate (see table).

At the time of writing these crocodiles are two years old and up to 1.7 metres in length or a growth rate of up to 6 cm. per month. One often sees captive reared crocodiles in a very stunted condition; in fact many people who should know better maintain that crocodiles only grow 30 cm a year. Given the right diet, sufficient cover and sunlight in a spacious

enclosure the growth rate of young crocodiles will be optimum, even better than that in wild crocodiles.

P.E.P. Deraniyagala, in TETRAPOD REPTILES OF CEYLON, 1941 gives the following growth rate of *C. palustris* (1 specimen)

			Length (cm)	*Weight (gm)*
Hatchling	September,	1934	25.5	70
Yearling	June,	1935	41	230
2 Year old	May,	1936	47.7	478

The following are mugger growth rates at Madras Crocodile Bank (71 and later, 56 specimens).

		Length (cm) Range/ Average	*Girth (cm) Range/ Average*	*Weight (Kg) Range/ Average*
Hatchling	June 1975	26-31/28	—	—
Yearling	June 1976	57-104/82	22-41/32	—
2 Year old	June 1977	90-170/130	32-70/50	3.5-12/8

MADRAS CROCODILE BANK,
MADRAS-600 022,
June 9, 1977.

R. WHITAKER
Z. WHITAKER

17. BREEDING RECORD OF THE INDIAN CHAMELEON (*CHAMELEO ZEYLANICUS*)

A female Indian chameleon laid 24 eggs at Madras Snake Park on 15.xii.75. Other females laid 33, 28, and 22 eggs. The eggs were average of 16 mm long. They were incubated in slightly damp, sterile sand in a plastic box with air holes. Most spoiled but several baby chameleons hatched 81 days later on March 6th. These measured about 3 cm including the tail and were subsequently released. Chameleons have been regularly observed mating at Madras Snake Park in late September and October. A good account of chameleon breeding is given by Trench (*JBNHS* 21, pp. 687-89).

MADRAS SNAKE PARK,
MADRAS-600 022,
June 7, 1977.

R. WHITAKER

Whitaker: *Trimeresurus purpureomaculatus*

Above: Left—*T. purpureomaculatus* (Melanistic phase); Right—*T. purpureomaculatus* (Normal coloration). *Below*: *T. purpureomaculatus* (Light phase ♀).

18. THE FEEDING HABITS OF THE CLIFF RACER, *COLUBER RHODORHACHIS* (JAN.)

While conducting a survey of reptiles of Poonch town and its vicinity (Jammu and Kashmir) recently, one of us (B.D.S.) caught a specimen of the Cliff Racer, *Coluber rhodorhachis* (Jan.) in the act of devouring another colubrid, *Sphalerosophis arenarius* (Boulenger) which is worth recording.

We are grateful to the Principal, Government Degree College, Poonch for the facilities and to Dr. A. G. K. Menon, Deputy Director, Zoological Survey of India, Madras 600028 for encouragement.

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December 30, 1975.

19. BIRTH RECORD OF THE ANDAMAN PIT VIPER (*TRIMERESURUS PURPUREOMACULATUS*)

(*With a plate*)

In June 1976 a 1 metre long female specimen of the Andaman Pit Viper was collected in the evening on the roadside near Port Blair, South Andaman. It was considerably larger than eight more specimens of this species collected in the same area and in North Andaman during the same month. The large female was brought to the Madras Snake Park and isolated in a display terrarium. On April 24th, 1977 M. Mani, Snake Keeper, noticed four live and one dead new born pit vipers in its cage. These were subsequently removed and placed in a separate enclosure for rearing. The average length of the juveniles was 14 cm. The parent is a uniform yellow-brown, the young vary from uniform dark brown to blotched and speckled patterns of light brown.

It is suggested that the mating season for this species is in February-March and that the captive female retained viable sperm from the 1976 season mating in the wild, a phenomenon reported in the literature for many other taxa.

This is the first breeding record for this species of pit viper apparently the most common and widely distributed pit viper of the Islands. The young are feeding well on juvenile Paddy Frogs (*Rana limnocharis*)

R. WHITAKER

MADRAS SNAKE PARK,
MADRAS 600022,
June 7, 1977.

20. ON SKIN SLOUGHING OF KING COBRAS, *OPHIOPHAGUS HANNAH* (CANTOR) IN CAPTIVITY

It is well known that snakes shed their skin at intervals which vary according to species, age, season and perhaps sex. But, perusal of the available literature (Deoras 1965; Gowda 1963 and Misra *et al.* 1976) did not reveal much information on the frequency of skin sloughing in King Cobras, *Ophiophagus hannah* (Cantor). This note, records some observations on sloughing of King Cobras in Captivity.

Two female King Cobras of Nandankanan Biological Park, Orissa, India, housed in a spacious semi-outdoor enclosure having a floor space of approximately 36 square metres; height 1.5 metres, were kept under observation for a period of 25 months from 1.ii.1975 to 7.iii.1977. In the Park, the King Cobras are offered freshly killed non-poisonous snakes such as *Ptyas mucosus* (Linn.) and *Xenochrophis piscator* (Schneider) once a week but the food intake is much reduced during cooler months.

Observations

At the beginning of observations, the two King Cobras measured 244 cm (Weight 1.57 kg) and 260 cm (Weight 1.67 kg) and 267 cm (Weight 2.43 kg) respectively on 1.i.1977. Both were therefore adults during the observation and little growth was observed.

The data summarised in Table I indicate that the King Cobras sloughed 21 and 20 times respectively during the 25 months period. Sloughing has been observed in all months except January. The process of shedding was completed in one, two and three consecutive days, beginning from the tip of the nose. During sloughing the skin of the head region with eye caps intact or broken was shed along with the skin of the rest of the body. The data indicate sloughing is more frequent during the period May to mid-November (hot and wet season) than in the cooler months. The inter-sloughing period in the first snake varied from 17 to 104 days with an average of 35.70 days and in the second from 17 to 84 days with an average of 35.60 days. The inter-sloughing period averaged 25.80 and 28.40 days respectively for the two snakes between May and mid-November (15 and 14 observations on each snake) as against averages of 65.40 and 55.80 days respectively for the two snakes during the period from mid-November and April (5 observations on each snake).

As is usual with other snakes, before sloughing, the body colour of king cobras becomes dull and the white stripes on the back become faint. A milky white opaque covering forms over the eyes. At this stage they cannot see well, remain inactive and generally refuse food. Soon after sloughing the eyes become clear, the body colour looks brighter, the animals become active and readily accept food.

Discussion

Misra *et al.* (loc. cit.) observed that a King Cobra shed its skin thrice in June, September and October during a period of 7 months from June, 1973 to December, 1973. They could not observe any sloughing in two other King Cobras during the months of November, 1974, December, 1974 and January, 1975.

According to Gowda (loc. cit.) King Cobras in captivity go on shedding their skins frequently and after each discard a layer will form like a cap on the eyes and as they are

TABLE 1

DETAILS OF SKIN SLOUGHING OBSERVED IN TWO KING COBRAS

Dates of last Sloughing.	Dates of Subsequent Sloughing.	Inter-Sloughing period in days.	Dates of last Sloughing.	Dates of Subsequent Sloughing.	Inter-Sloughing period in days.
	Specimen No. I			*Specimen No. II*	
21.2.75 to			5.3.75 to		
22.2.75	27.4.75	63	6.3.75	15.5.75	69
27.4.75	26.5.75	28	15.5.75	2.6.75	
26.5.75	20.6.75	24	2.6.75	30.6.75 to	
				2.7.75	27
20.6.75	8.7.75 to		30.6.75 to		
	9.7.75	17	2.7.75	28.7.75	25
8.7.75 to					
9.7.75	1.8.75	22	28.7.75	28.8.75	30
1.8.75	31.8.75	29	28.8.75	19.9.75	21
31.8.75	29.9.75	28	19.9.75	15.10.75	25
29.9.75	22.10.75 to				
	23.10.75	22	15.10.75	11.11.75	26
22.10.75 to	18.11.75 to		11.11.75	25.12.75 to	
23.10.75	20.11.75	25		27.12.75	43
18.11.75 to	30.12.75 to		25.12.75 to	21.2.76 to	
20.11.75	31.12.75	39	27.12.75	22.2.76	55
30.12.75 to	4.3.76 to		21.2.76 to	22.3.76 to	
31.12.75	5.3.76	63	22.2.76	24.3.76	28
4.3.76 to			22.3.76 to	7.5.76 to	
5.3.76	3.5.76	58	24.3.76	9.5.76	43
3.5.76	1.6.76	28	7.5.76 to	23.6.76 to	
			9.5.76	24.6.75	44
1.6.76	4.7.76	32	23.6.76 to	13.7.76 to	
			24.6.76	14.7.76	18
4.7.76	1.8.76	27	13.7.76 to		
			14.7.76	5.8.76	21
1.8.76	23.8.76	21	5.8.76	9.9.76	34
23.8.76	18.9.76	25	9.9.76	5.10.76 to	
				6.10.76	25
18.9.76	18.10.76 to		5.10.76 to	17.11.76 to	
	20.10.76	29	6.10.76	18.11.76	41
18.10.76 to			17.11.76 to	11.2.77 to	
20.10.76	20.11.76	30	18.11.76	12.2.77	84
20.11.76	5.3.77	104	11.2.77 to		
			12.2.77	—	—

adhesive these layers are generally not removed along with the skin. He further states that these caps are to be removed with the help of forceps and a scalpel and attributed the causes to unnatural conditions in captivity such as lack of ponds, drains, thorny bushes, and rough narrow crevices etc. in their enclosure. This condition is not observed in the Park's specimens because they have been provided with suitable housing to cast off their skin in the natural process. To achieve this, rockeries with irregularly projecting stones, bushes, holes, dry tree trunks, rough stony wall and a big water pond to swim about have been provided inside the King Cobra enclosure.

Deoras (loc. cit.) states that the snakes slough more frequently in the summer and less during cooler season and the periodicity of sloughing ranges from 72 to 210 days. Regular sloughing of skin is considered as a sign of good health among snakes.

The observations on growth further suggest that the King Cobras grew 6 to 7 cm only during a period of two years. This suggests that the growth of King Cobras in later part of their lives is very slow especially in captivity.

ACKNOWLEDGEMENT

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July 11, 1977.

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21. RECORD OF THE BENTHIC LEUCOSIID CRAB, *RANDALLIA EBURNEA* ALCOCK IN THE NORTHERN ARABIAN SEA

(*With a photograph*)

The occurrence of the Benthic Gymnopleuran crab, *Notopus dorsipes* Fabricius in the northern Arabian Sea based on the study of the material collected during the Oceanographic Expedition on INS DARSHAK from December, 1973 to May, 1974 was reported earlier by Daniel & Chakrapani (1977). In this note, the record of a few specimens of a Leucosiid Brachyuran, *Randallia eburnea* Alcock collected from depths of 80-85 metres at latitude 19° 30′N and longitude 70° 04′ E in January 1974, is reported. This species has never been rediscovered in the Indian seas, since its original record by Alcock in 1896 from off Laccadive islands at a depth of 30-metres. Hence this is the second record in the Indian seas. This species has also been reported from off Western Australia at 86-metres (Tyndale-Biscoe & George 1962), in East Indies—Siboga Expedition—(Ihle 1918) and Japan (Sakai 1937). This species is distinguished by the posterior margin of the carapace being armed with three petalloid processes (Photograph 1, dorsal view).

S. No.	Material from Laccadive sea–after Alcock, 1896 & 1897	Material from East Indies after Ihle 1918	Material from Western Australia after Tyndale–Biscoe and George 1962	Present material from Northera Arabian Sea
1.	Dactyls with few hairs on tip only.	Same as Alcock	Distal one third of first to third dactyls with long hairs.	Distal one third of first dactylus and distal half of second and third dactyls with hairs. The last dactylus devoid of any hairs
2.	3rd–5th abdominal segments fused, though all clearly recognisable.	3rd–6th abdominal segments fused, all clearly recognisable.	2nd – 6th abdominal segments fused only, faintly recognisable by slight bulging at sides.	2nd – 6th abdominal segments fused; all segments clearly discernible demarcation between IInd - IIIrd, Vth - VIth deeper.
3.	No tooth on penultimate segment of abdomen.	Same as Alcock	Distinct flattened tooth on penultimate segment of abdomen.	Abdomen with blunt tooth on second segment No tooth on penultimate segment.

The specimens examined agree in most respects with the general description and figures given by earlier authors, i.e. Alcock 1896, p. 197 (description); Illustration of RIMSS Investigator 1897, pl. 30, fig. 4; Ihle 1918, p. 246, Sakai 1937, p. 132 and 1940, p. 37 and Tyndale-Biscoe & George 1962 (diagnostic features) except in minor morphological variations which are presented in the table.

Our grateful thanks are due to Captain K. L. Chopra, Commanding Officer, I. N. S. DARSHAK for help in the collection of samples and to Dr. S. Khera, Joint Director-in-Charge, Zoological Survey of India, Calcutta for facilities given to participate in the Expedition.

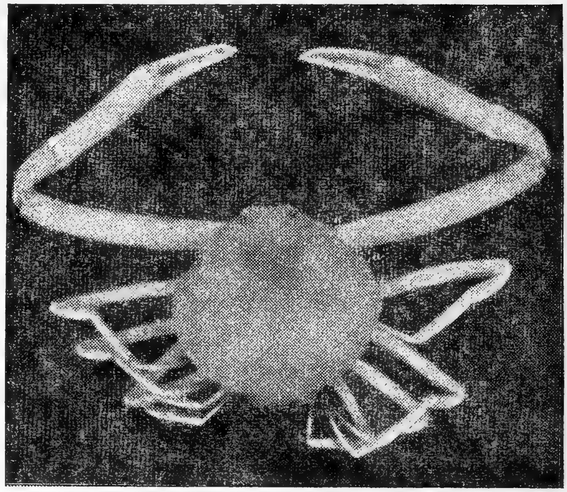

Photo. 1. *Randallia eburnea* Alcock 1896. Dorsal view.

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June 3, 1977.

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22. DISCONNECTED OBSERVATIONS ON A SPECIES OF *SCOLAPENDRA*

These disconnected observations and experiences are probably relevant to Lavkumar Khacher's note on a predatory centipede of the genus *Scolapendra* published in *JBNHS* Vol. 74 No. 1—in all cases, the same centipede is meant, thick-bodied and dorso-ventrally flattened and about 15-17 cm long, conspicuously banded chrome yellow and a bluish dark slate (almost a cold black) on the body and with scarlet-vermilion legs.

In the summer of 1947 I was playing a game of cards in the club-house in Sandur (now in the Bellary district of Karnataka) before dinner, when a particularly large banded centipede of this species emerged from the rolled up cricket-mat in a corner of the room. Everyone demanded its instant execution, saying it was a specially deadly reptile, and on my pointing out that no centipede was lethal to men and anyway none was a reptile, my friend, the late Mr. V. S. Lad, bet me five rupees that I dared not allow the brute to bite me. Removing my shoes, I approached the curled up centipede and prodded it with my toes to provoke it to bite, but this only made it run towards the cover of the cricket-mat, whereupon I pinned it down firmly by its middle with my great toe. It then turned back upon itself and firmly clasping the toe with its legs, bit me: I could feel the pain and prick not only of the bite but also of the clasp of the several pairs of legs. The centipede had to be killed to remove it from my great toe with no risk of laceration of the skin during the removal. I felt much irritation and some pain, and very soon the toe swelled up, so that I had to walk home that night carrying my shoes in my hand. The next day the toe was still swollen, painful and throbbing—no treatment, beyond bathing the toe with soap and water, was given, so as to conform to the terms of the bet. I could not play in a cricket match that day because I could not pull on my boots. The bite was clearly visible, and I could feel, or imagine I felt, the places where the centipede had gripped my toe with its chitinous sharp legs, though these were not clearly visible. Mr. Lad did not pay the bet that day, as he prudently waited to see if any belated consequences would ensue, but on the third day, when the swelling subsided of its own accord, he paid up like a gentleman.

One morning, a good many years ago (the date and notes are not readily traceable, but I did make a note of it and my son, consulted 3 days ago, remembers the incident perfectly) my son and I were standing beneath the wood-apple tree in my backyard (one of the biggest in Madras) discussing a weed which had recently made its appearance there, when we saw a centipede of this species come out of the leaf litter on the ground. A large male bloodsucker (*Calotes versicolor*) which was up the tree's bole and well above us also saw the centipede, and rushed down the tree, actually leaping the last two feet down to the ground in its hurry, rushed up to the centipede and with no preliminaries swallowed it—the head and a quarter of the length were taken in at the first bite and the rest of the squirming, violently wriggling length of the prey swallowed in a few seconds, before that bloodsucker returned to the tree. I watched it for an hour afterwards, and it exhibited no signs of discomfort or even satiation, coming down again awhile later to seize and swallow a mole-cricket.

Three nights ago my cook, a nervous woman, called me down to deal with a large centipede

(also of the same kind) that had taken refuge in the bamboo basket (a little more than 2-foot across at its mouth and about 12 inches deep) she uses for conveying kitchen refuse to the municipal refuse-bin. The centipede had its head and tail inside the upside-down basket and about 2 in. of its middle section exposed on top: remembering past experience, I seized this middle section in a pair of long-nosed pliers and lifted the centipede out. To my surprise the entire basket came up, and I had to hold the basket down with one hand to extract the centipede with the other, so powerful was the grip of its legs on the woven bamboo. Since I had injured it badly, I killed that centipede with a slap of my chappal, and in the process noticed that this species of centipede does not glow all over with a phosphorescent glow when so killed as the reddish brown centipede, slightly smaller and thinner and common in houses, does.

2/14 EDWARD ELLIOT ROAD,
MADRAS-600004,
September 23, 1977.

M. KRISHNAN

23. A NOTE ON THE DISCOVERY OF THE MALE OF *ACRITOCHAETA DISTINCTA* MALL. (DIPTERA, MUSCIDAE)

Acritochaeta distincta (Syn. *Atherigona distincta* Mall.) was first collected from Guindy, Saidpet, S. India in 1909 by W. S. Pattton and described by Malloch (1923). The author described the species from a series of 6 specimens. The holotype ♀ and 3 ♀♀ paratypes are deposited at the British Museum (Natural History). The male was not described. Subsequently, two further specimens of the female were taken from Calcutta in 1907 and 1915 and are also lodged in the British Museum.

In the course of work at ICRISAT at the break of the monsoon in 1976, when intensive surveys of shoot-flies present in local grasses and cultivated cereals were conducted using square pan water traps baited with fish meal, a very large number of an unusual *Acritochaeta* were attracted and caught. Most of the specimens were female, but males were also present. Specimens submitted to Mr. A. C. Pont at the British Museum were identified as *A. distincta*. The male of the species needs to be described at some future date.

Data from traps in the period mid-May to mid-July (20.5.76 to 17.7.76) showed that of a total of 2780 *Atherigona* and *Acritochaeta* specimens attracted to 20 traps sited at various representative locations at ICRISAT Research Centre, 313 were males. Of these males, 84% (266) were *Acritochaeta distincta*. Some 248 of these were all taken at one particular trap. Detailed investigation over the next 3 weeks confirmed these data in that in the period 18.vii.76 to 7.viii.76 of 8677 flies taken, 816 were males of which 80% were *A. distincta*. At this stage, whereas 554 males of the species were all recovered from one trap it was observed that traps at 3 other sites became productive. It was clear that traps in proximity to the palm, *Borassus flabellifer* L. (Palmae), were the productive ones. Investigation of rotting palm nuts revealed large numbers of eggs, larvae and pupae of *A. distincta*. These are as yet undescribed, but specimens have been lodged at the British Museum (NH) for inclusion in any revision of the genus carried out. The host

plant of the insect is not recorded in Malloch & Rao 1925.

In the period 8.viii.76 to 19.viii.76 when trapping was discontinuous, the numbers of *A. distincta* fell considerably and an allied species *Acritochaeta orientalis* became dominant. A significant observation was the relatively localised nature of the occurrence of the fly and its apparent seasonality. This has implications with respect to the study of *Atherigona soccata* Rond., sorghum shoot-fly which is being contined at ICRISAT since it indicates that in this related insect diapause between the fruiting seasons of the palm occurs.

ACKNOWLEDGEMENTS

We are grateful to Mr. A. C. Pont for identification of the species and for furnishing details of the existing holotype and paratypes.

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24. MORMON BUTTERFLY—ITS STATUS IN BOMBAY

With the rains and the wet weather would emerge our true 'Spring' and with it would start a number of butterflies flitting about displaying their showy colours for the joy of the natuarlist. It is the right time for a butterfly enthusiast to keep a look out for that showy butterfly, the Mormon *Papilio polymnestor*. In Bombay and Salsette among the 120 or so species of butterflies recorded, this insect has been put down as 'very scarce', though numbers of it may be encountered in certain years.

E. H. Aitken (EHA) commenting on the butterflies in the collection of the Bombay Natural History Society admitted in 1887 that he did not understand the distribution of the butterfly and that it is absolutely unknown in Bombay and imagined that it was so throughout the Konkan, but became one of the most familiar species as soon as one reached a level of 2000 ft. According to EHA the butterfly did not occur in the Deccan generally, but in Poona it frequented old gardens in the city.

In response to EHA's comments W. F. Melvin recorded in the Society's *Journal* two ragged but strong in flight specimens in Sivadi (present Sewree in Bombay) woods and the cemetery in March 1889. J. A. Betham recalled of having seen it frequently at Dapoli (70 miles south of Bombay in S. Konkan) in his early days and how its appearance in their

garden used to cause a display of the liveliest interest, the younger members of the family rushing out to get a nearer view and possibly secure a good specimen (*JBNHS* 1889).

The next recorded instance in Bombay of the butterfly is by A. E. G. Best in 1951 when he saw two individuals at Tulsi Lake and again came across an individual on 6.xi in 1955. J. I. Alfrey, a knowledgeable lepidopterist editorially referred to Mr. Best's note of having seen an individual in the garden of 'Silver End', Strand Road, Colaba (Bombay) travelling across the harbour.

The concensus of opinion among lepidopterists was that the butterfly was a 'very scarce' migrant in Bombay until D. E. Reuben studied the butterfly (1960-62) in his garden in Pali Hill, Bandra, and suggested that Pali Hill is not merely a point on the local migration of the butterfly and that there is a seasonal appearance on Pali Hill, which he hoped might be tested by extended observations.

An opportunity of studying the butterfly at Pali Hill came my way when my services were put at the disposal of Dr. Salim Ali to work on the ten volumes of HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN. The garden around his study was ideally suited for the purpose. I first saw the butterfly on 23rd September 1970, a solo flighting *purposefully* in an east-west direction, and never even alighting to feed on the crossandra bloom in the garden, the nectar of which is its favourite food in the south. From 23rd September till 27th October, a number of individuals were seen in the same steady purposeful flight, always east to west, and hardly higher than about 2 m above the ground, and never even alighting on the blooms in the garden. An exception to the above behaviour was one individual seen on 4th October 1970 at Tulsi Lake, leisurely flighting from bush to bush and alighting on blossoms to feed. Observations from mid November 1970 to mid March 1971 showed that the butterfly was no more engaged in the purposeful flight as in September-October, and were flighting aimlessly from one flowering plant to another to feed.

Since March 1971 I have not come across a single specimen in the Bombay area, though I have looked particularly for it, and it is intriguing why a butterfly so commonly met during certain years is completely absent in others.

After writing the above Mr. Salman Abdulali informs me of a *Papilio polymnestor* he saw at Bandra Station (Bombay) on 10th June 1977.

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June 14, 1977.

25. NEW RECORD OF MYRMECINE ANTS AS PESTS OF BHENDI, *ABELMOSCHUS ESCULENTUS* MOENCH.

Myrmicaria brunnea Saunders, *Phidologiton diversus* (Jerdon) and *Tetramorium smithi* (Mayr.) (Myrmecinae); Formicidae; Hymenoptera) were recorded as serious pests of the bhendi crop in the Instructional Farm attached to the College of Horticulture, Mannuthy,

Kerala during December 1976—January 1977, for the first time. Among the three species, *T. smithi* was relatively more abundant.

The feeding habits of all the forms are quite similar. They cut and feed on the petals, the ovarian tissues and the pollen grains. The buds as well as the flowers are equally preferred for feeding. The infested flower buds and flowers do not develop further and are quite often shed.

The ants also cause serious damage to the developing fruits by scraping the epidermal layer in irregular patches and later by internal burrowing inside the pulp through tortuous tunnels. The development of the infested fruits is arrested and these are often badly malformed. On each plant 80-90 per cent of the developing fruits are thus damaged. Infestation by the ants was brought under rapid control by spot dusting of flower buds, flowers and fruits with phosalone 4% DP. As a prophylactic measure, ringing around the base of plants with either BHC 10% DP or phosalone 4% DP was found to be quite effective.

Bingham (1903) reported the distribution of *M. brunnea* throughout India, of *P. diversus* in W. India, Poona, Kanara and *T. smithi* in Bengal West and south India, without mentioning their host range. *M. brunnea,* which occurs almost every where on the plains of India occasionally feeds on the foliage of the garden plant *Arctotis grandis* (Fletcher 1920). According to Ayyar (1963) *M. brunnea* is of common occurrence in households in South India.

The other species of *Myrmicaria* reported as crop pests include *M. eumenoides* Gerst. on citrus in Nyasaland (Smee 1931) and *M. natalensis* F. on flowering plants and vegetable crops in Tanganyika (Ritchie 1935). *T. caespitum* L. is recorded to feed on cruciferous vegetables and brinjal in Virginia (Smith 1916) and on sugar beets in California (Lange 1961).

We are grateful to Dr. M. G. Ram Das Menon, Emeritus Scientist, Kerala Agricultural University, Mannuthy for identification of the insects.

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26. DOES *ADIANTUM AETHIOPICUM* LINN. EXIST IN INDIA?

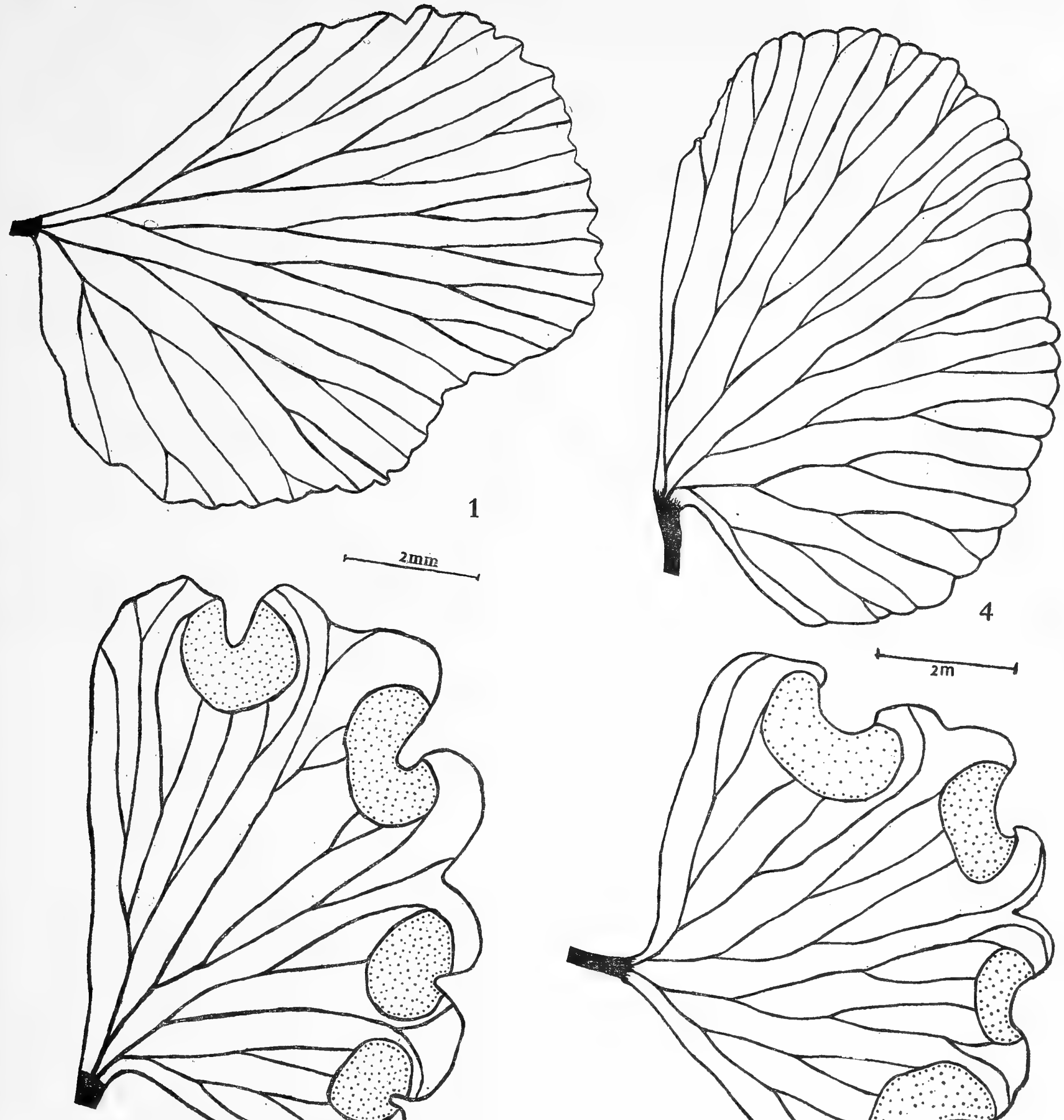
(*With six text-figures*)

Beddome (1863, 1883, 1892) reported *Adiantum aethiopicum* Linn. from Nilgiri and Palni mountains at high altitudes. Hope (1901) endorsed a South Indian distribution for the plant. Blatter & D'Almeida (1922) reported it to be a rare species of higher elevations from Bombay Presidency. Kachroo & Nayar (1952) seem to have collected the plant from Eastern India. Kachroo (1953) in his account on the ferns of Assam also mentions the species. Nayar (1962) states that the species exists in Western Ghats at higher elevations and in the Assam plains, reaching up to 1500 m. Bir & Vasudeva (1971) reported it from Kodaikanal, Tamil Nadu. However, Pichi-Sermolli (1957) does not include India in the distribution of the taxon. According to him (p. 695), "it represents the species distributed in South Africa, Australia and New Zealand". This statement as well as study of the specimens of *Adiantum* present in the Central National Herbarium, Sibpur, Howrah, Industrial Section of the Indian Museum, Calcutta, and the regional circles of the Botanical Survey of India at Allahabad, Coimbatore, Dehra Dun, Poona and Shillong raised doubts in our minds as to whether A. *aethiopicum* exists at all in India. From the data at hand, we believe that the Indian plant which was up till now called *A. aethiopicum* is another species, *A. thalictroides* Willd. ex Schlecht. Beddome (1863) did infact treat *A. aethiopicum* as conspecific with *A. thalictroides* but later on he (Beddome 1883, 1892) did not mention *A. thalictroides* in the synonymy of *A. aethiopicum* Linn.

In the nineteenth century *A. thalictroides* was regarded as a good species by some authors (*see* Kunze 1845; Braun 1867) although others had considered it as similar to *A. poiretii* Wikstr. Pichi-Sermolli (loc. cit.) has clearly shown how *A. poiretii* is distinct from *A. thalictroides.* Other than Beddome (1863), no Indian worker seems to have equated *A. aethiopicum* with *A. thalictroides.* Probably, Beddome realised his mistake and omitted *A. thalictroides* from the synonym of *A. aethiopicum* in his HANDBOOK (1883) and supplement (1892). The difference between *A. aethiopicum* and *A. thalictroides* are so very clear cut that they can be identified easily by the following key (see also the figures) provided by Pichi-Sermolli (loc. cit.)

"Fronds 25-60 cm long, borne on the rhizome far from each other; paleae of the rhizome brown-straw or straw-coloured, thin, nearly transparent, *entire on the edges and loosely reticulate;* ultimate pinnules closer to each other, persistent; the sterile pinnules with dentate edges; *veins ending in the teeth* .... *A. aethiopicum*
Fronds 35-100 cm long, borne on the rhizome not too far from each other; paleae of the rhizome brown-copper-coloured, thick *irregularly ciliate-dentate* and, densely reticulate; ultimate pinnules far from each other, divoricate, and *easily and precociously caducous,* sterile with crenate edges; *veins running to the sinuses* between the crenae .... *A. thalictroides*

In none of the collections from the various herbaria mentioned above, could we come across even a single sheet of *A. aethiopicum.* All the material kept as *A. aethiopicum* belong to *A. thalictroides.* Therefore, the earlier reports regarding the existence of *A. aethiopicum* in India need confirmation. It is to be pointed out that Aitchison (1879), Hope (loc. cit.) and Stewart (1957) mention that the pinnules fall off in *A. aethiopicum.* From this it is



Figs. 1-3. *Adiantum aethiopicum* Linn. Fig. 1. Sterile pinna. Fig. 2. Fertile pinna. Fig. 3. Rhizome scale. Figs. 4-6. *A. thalictroides* Willd. ex Schlecht. Fig. 4. Sterile pinna. Fig. 5. Fertile pinna. Fig. 6. Rhizome scale.

[Figs. 1-3 are drawn from specimen Koondak, Travancore, 13-v-1883, *Levinge* s.n. (CAL 6046) and Figs. 4-6. are drawn from specimen Polynesia, 1854, Thomas Moore's Fern Herbarium, s.l.s.n., purchased in 1885 and distributed by Herbarium Royal Botanic Garden, Kew (CAL) 6644)].

clear that the species they refer to are not. *A. aethiopicum*. Similarly, Nayar (1962) in his account of *A. aethiopicum* states (p. 39) that the scales have "more or less smooth margins with a few short blunt protuberances towards the base and a few narrow teeth towards the apex" which means that his specimens are also not true *A. aethiopicum*.

Baddome (1883) combined *A. emarginatum* Bory and *A. aethiopicum* L. We have shown elsewhere (Nair & Ghosh 1976) that these two taxa are clearly distinct from each other. Nayar (1962) cites *A. assimile* Sw. as conspecific to *A. aethiopicum* Linn. We have critically examined the sheets of *A. assimile* Sw. from Australia (Specimen No. N. Holland, *S. Mossmou* 612, 1850; Between Perth and K. B. Sound, W. Australia *W. H. Harvey* s. n. April, July 1854; Sydney, New South Wales, S. 1., s. n.) and we agree that *A. aethiopicum* Linn. and *A. assimile* Sw. are conspecific.

The Indian material which were earlier identified as *A. aethiopicum* Linn. agree in all respects with specimens of *A. thalictroides* Willd. ex Schl. from Africa present in the Central National Herbarium.

Since *A. thalictroides* is not previously reported from India and has been confused with *A. aethiopicum* a full description of the Indian plant is provided here.

Adiantum thalictroides Willdenov ex Schlechtendal, Abumb. Pl. 5: 53. 1832; Pichi-Sermolli in Webbia 12: 687, 1957. *A. aethiopicum* auct. pl. non Linn.

Rhizome creeping, 0.3-0.5 mm in diameter, densely covered with brown or copper-coloured, ovate-lanceolate, thick, 0.4-0.5 cm long, 1 mm broad scales with ciliate to ciliato-dentate to ciliato-dentate margin and cordate base with dense reticulations; laminae oblong-ovate or ovate; bi- to quadripinnate; stipes 7-20 cm long, dark brown to purplish-black, glossy, glabrous, grooved above; rachis up to 80 cm long, dark brown to black, glossy glabrous; pinnae broadly ovate-lanceolate; pinnules divaricate with slender, 0.2-0.7 cm, glossy, black stalk, 1 to 1.4 cm, caducous, thin in texture, often with cartilagenous and thickened surfaces, glabrous crenate margin and veins running into the sinusus between the crenae; fertile pinnule slightly and broadly notched in correspondence with reflexed flaps of leaves with inconspicuous veins; sori elongated, subreniform; annulus 16 to 18 celled; spores tetrahedral, brown, 36-37 x 50 μ.

Icon. Zenker, Pl. Ind. t. 11, 1835, Sim, Ferns S. Afr. ed. 2, t. 124, 1915 (sub *A. aethiopicum*); Pichi-Sermolli in Webbia 12: fig. 10, 12, 1957.

Material examined: Commina, *Beddome* 36, Aug. 1, 1878 (CAL 5925); Deviculam (Devikolam), 1819 m, Travancore, *A. Meebold* 13427, Dec. 1910 (CAL 6045); Koondak, 1677 m, Travancore, *H. C. Levinge* s. n., May 13, 1883 (CAL 6046, 6050); May 2, 1883 (CAL); Madras, *Hooker f.* & *Thoms.* s. n. (CAL 6049); Nilgiri, *Blanford* s. n. (CAL); *G. Bidie* s. n. 1873 (MH 59141); Ootacamund, *G. King* s. n. Aug. 1, 1878 (CAL 5925), Aug. 15, 1878 (CAL 6047); Peninsular India, Wight 3118, distributed at the Royal Botanical Garden, Kew, 1866-68 (CAL 6051); Pumbarai, Pulneys, Madurai Dist., *Anonymous* 16607, July 21, 1920 (MH 59145, 59147).

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STEWART, R. R. (1957): The ferns and fern allies of West Pakistan and Kashmir. *Biologia 3*: 133-164.

27. NEW RECORDS OF FABACEAE FOR MAHARASHTRA STATE

In this note two species of Fabaceae not earlier recorded by either Cooke (1903) or Haines (1916) have been recorded for the first time from Chandrapur district, Maharashtra State, thus extending their distribution. The specimens cited have been deposited in the herbarium of Botanical Survey of India, Western Circle, Poona (*BSI*).

1. **Desmodium brachystachyum** R. Grah. ex Benth. in Miq. Pl. Jungh. 223, 1852; Baker in Hook.f. Fl. Brit. India 2: 171, 1876; Duthie Fl. Upp. Gang. Pl. 1: 265, 1960 (Repr. Edn.); Haines Bot. Bih. Or. 2: 277, 1861 (Repr. Edn.); Prain Beng. Pl. 1: 305, 1903.

Herb with unifoliate leaves. Flowers light blue; pods included, greenish. Rare, in moist areas.

Fl. & Frt.: Sep.-Nov. *Loc.* Devada forest (Ghot range) *Malhotra* 123181.

General distribution: Chota Nagpur, Upper Gangetic Plain, Bihar.

2. **Uraria alopecuroides** Wt. Ic. t. 290, 1840. *U. repanda* Wall. ex Baker in Hook. f. Fl. Brit. India 2: 156, 1876; *Doodia alopecuroides* Roxb. Fl. Indica iii, 368, 1820; Prain Beng. Pl. 1: 301, 1903.

Undershrub with trifoliate leaves; flowers light pink, pods glabrous 1-2 jointed. Rare in shady areas.

Fl. & Frt.: July-Sept. *Loc.* Laggam forest, Laggam range, *Malhotra* 140040.

General distribution: N. Circars, N. E. India and Burma.

ACKNOWLEDGEMENTS

We are thankful to the Director, Botanical Survey of India, Howrah for facilities and also to the Deputy Director, Central National Herbarium, Howrah, for help in identification.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE, POONA-1,
June 28, 1976.

S. K. MALHOTRA
S. MOORTHY

REFERENCES

COOKE, T. (1903): Flora of the Presidency of Bombay.

HAINES, H. H. (1916): Descriptive list of trees, shrubs and economic herbs of the southern circle, Central Provinces.

28. *NICOTIANA PLUMBAGINIFOLIA* VIV. (SOLANACEAE)— A NEW RECORD OF DISTRIBUTION FOR N.W. HIMALAYAS

Nicotiana plumbaginifolia Viv. (Elench. Pl. Hort. Dinegro 26, t 5, 1802; Haines, Bot. Bih. & Or. 616), is a species native to Mexico and West Indies, introduced in India in the past and is now a weed. Raizada (1936)[1] recorded it from Dehra Dun in the Upper Gangetic Plain.

During floristic studies of district Chamoli I collected on 4-4-1975 this species near Gauchar on the walls separating cultivated fields under collection No. 2146 *Nautiyal*. It appears that the taxon has recently appeared within the area. This species is characterised by rosette of large radial leaves, smaller cauline leaves and salver-shaped corolla of greenish-white flowers.

BOTANY DEPARTMENT,
MEERUT UNIVERSITY,
MEERUT, INDIA,
September 7, 1976.

K. N. NAUTIYAL

[1] RAIZADA, M. B. (1936): Recently introduced or otherwise imperfectly known Plants from upper Gangetic Plain. *J. Indian Bot. Soc. 15*:149-167.

29. A NOTE ON *KAEMPFERIA ANGUSTIFOLIA* ROSCOE

During the identification of a collection of plants from different districts of West Bengal, we came across some specimens of a taxon of *Kaempferia* Linn., which were later indentified as *Kaempferia angustifolia* Roscoe. Earlier reports of its occurrence as a cultivated plant were made by (Roxburgh 1814; Voigt 1845) in Bengal. Hooker (1890) also recorded this taxon from undivided Bengal on the basis of observation made by Roxburgh (1814). Prain (1903) recorded same taxon from the hills of Northern Bengal and no report of its occurrence as wild plant has so far been made by any investigator. We collected specimens of this plant from Baruipur, 24-Parganas and the species was also seen growing wild in the district of Hooghly. Hence, this appears to be the first record of the species in the wild condition

among the plants of West Bengal.

Kaempferia angustifolia Roscoe in Trans. Linn. Soc. VIII. 351. 1807; Roxb. Hort. Beng. 1, 1814; Fl. Ind. V. I. 17, 1832 Carey ed.; Voigt, Hort. Suburb. Cal. 566, 1845; Fl. Brit. Ind. V. 219, 1890 *K. undulata* Link., Teysm. & Biennen in Fl. Ind. Bat. III 598. Stemless herb with large white, faintly purple flowers tinged towards the apex with lilac lip and dark-purple at centre.

Specimens examined: ASSAM: Jowai, Jaintea Hills. May 13, 1896, *S. G. Rita* s.n. Acc. No. 466239 (CAL): Herb. Sulp. *Kurz*. H.B. Acc. No. 466238 (CAL): WEST BENGAL: Baruipur, 24-Parganas. 10th May, 1971, *J. C. Das* 45 Acc. No. 572440 (CAL).

Flowering & Fruiting: May—July.

Distribution: Trop. Asia.

Ecological Notes: The plants grow gregariously along drains and nallahs on damp soil under the shade of large trees (*Polyalthia longifolia* Sonn.) Thw.

R. B. GHOSH
BARIN GHOSH
J. C. DAS

CENTRAL NATIONAL HERBARIUM,
BOTANICAL SURVEY OF INDIA,
INDIAN BOTANIC GARDEN,
HOWRAH-3,
July 29, 1976.

REFERENCES

HOOKER, J. D. (1890): Flora of British India. *2*: 219.

PRAIN, D. (1903): Bengal plant. *2*:780.

ROXBURGH, W. (1814): Hortus Bengalensis. 1.

VOIGT, J. C. (1845): Hortus Suburbans Calcuttensis : 566.

30. *CARDUUS TENUIFLORUS* CURTIS, (ASTERACEAE): AN ADDITION TO THE FLORA OF INDIA

(*With a text-figure*)

While studying the Asteraceae of the Western Himalayas, the senior author came across a species of *Carduus*, which on critical study and perusal of the literature was found to be *C. tenuiflorus* Curtis so far not recorded from the Indian subcontinent. The specimen was sent to Dr. S. M. A. Kazmi of Peshawar University (Pakistan), who confirmed the identification. The plant has been described and illustrated. The voucher specimens have been deposited in the Herbarium, Kashmir University.

Carduus tenuiflorus Curtis, Fl. Lond. Fasc. 6, pl. 55.1790-98; Clapham, *et al.* Fl. Brit. Isl. ed. 2, (1962).

Annual herb with a stout tap root; Stem 16-18 cm long, erect, ribbed, cottony above, branched, continuously spinous winged. Leaves 3-9 cm long and 1-8-4.5 cm broad, sessile, oblong-oblanceolate, acute, decurrent, pinnatifid, lobes and apex strongly spinous, cottony beneath. Heads 15-17 mm long and 8-10 mm broad, cylindrical, sessile, usually 2-4 clustered at the apex of branches, wooly at the base, stem leafy close beneath them; Phyllaries in many series, imbricate, outer phyllaries 5-6

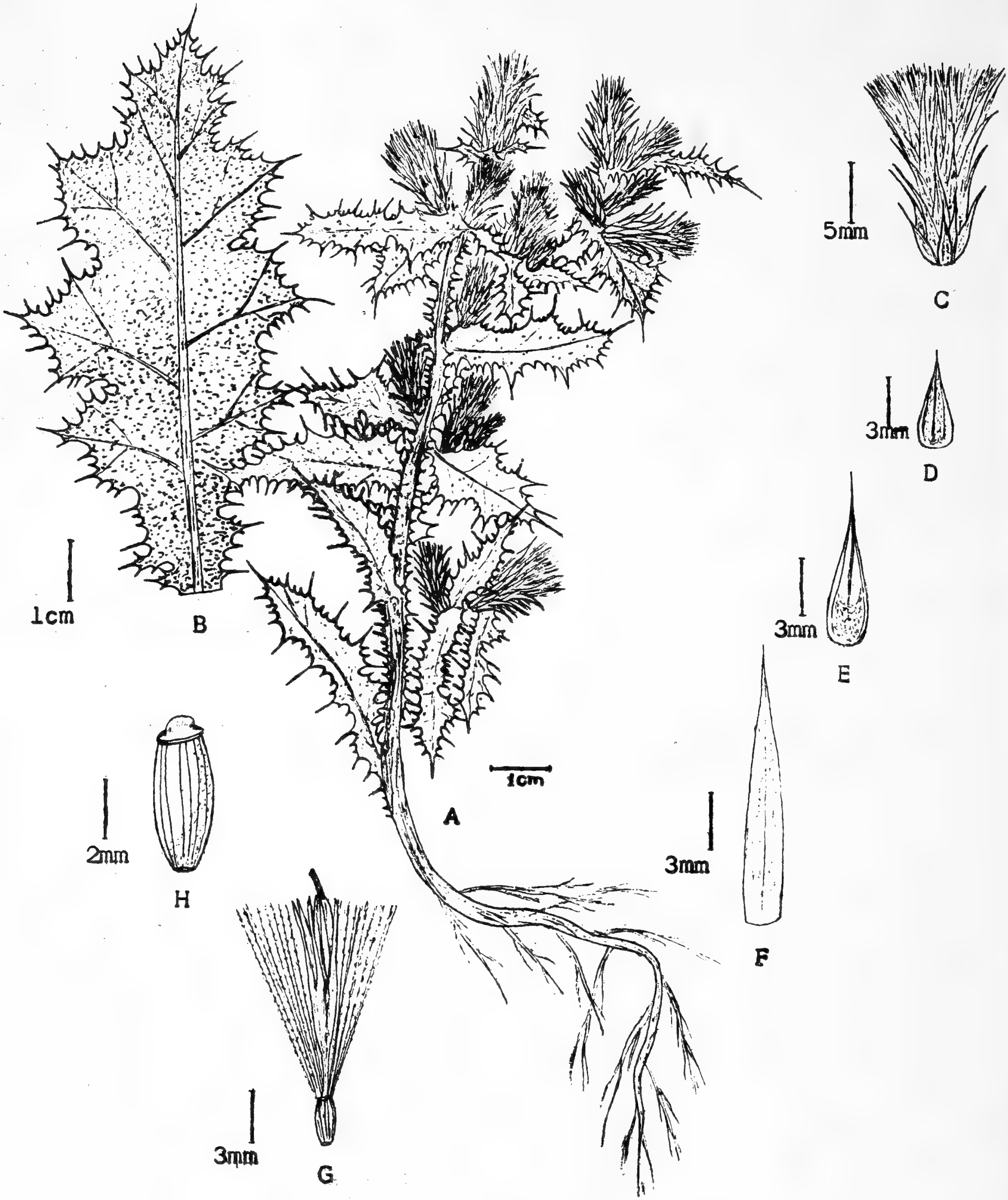

Fig. 1. *Carduus tenuiflorus* Curtis
A. Plant; B. Lower leaf; C. Head; D. Outer phyllary; E. Middle phyllary; F. Inner phyllary; G. Floret; H. Achene.

mm long and 2 mm broad, ovate, acuminate, scarious margined, slightly woolly below the rigid apical spine; middle phyllaries 10-12 mm long and 2 mm broad, broadly lanceolate, acuminate, scarious margined, margins scabrous below the ± erect or outwardly curved rigid spine, slightly wooly beneath the spine; inner phyllaries 15-17 mm long and 1.5-2 mm broad, lanceolate, acuminate with long pointed apex, scarious, glabrous; receptacle densely bristled; florets tubular, pinkish, 12-15 mm long; corolla lobes long, acute, glabrous; androecium 4.5-5 mm long, filaments 1-1.5 mm long, hairy below, anthers with acuminate apex and sagittate base; style 7-11 mm long, arms with divided tips, obtuse, glabrous, brownish; achene 3-4 mm long, 1-2 mm broad, compressed, oblong, truncate, narrowed at the base, finely 10-11 nerved, glabrous, brownish; pappus copious, 10-12 mm long, in many series, bristles unequal, scabrous, sordid white, forming a basal deciduous ring.

A R A 1098 Uri (Kashmir) road sides, dry waste land, July 26th, 1975.

The plant is common in the valley and it appears that the species has been confused with *C. pycnocephalus* L. reported from N.W.F. provinces (Pakistan) which it resembles closely. *C. pycnocephalus* L. however, differs from *C. tenuiflorus* Curtis in having stem discontinuously winged and naked beneath the heads.

We are greatly indebted to Dr. S. M. A. Kazmi, P.C.S.I.R. Lab., Peshawar University, (Pakistan) for the confirmation of the identification.

A. R. AZAD
G. N. JAVEID

DEPARTMENT OF BOTANY,
UNIVERSITY OF KASHMIR,
SRINAGAR-190 006,
KASHMIR,
August 24, 1976.

31. *MALVA VERTICILLATA*—A LITTLE KNOWN PLANT OF ECONOMIC IMPORTANCE

The leaves of various species of *Malva*—both wild and cultivated are consumed (Uphof 1968). In India, the tender leaves and shoots of *Malva parviflora, M. rotundifolia, M. sylvestris* and *M. verticillata*—confined to tropical and/or temperate habitats, are used (Watts 1971). Of these, *M. verticillata* is grown as a cultigen in West Bengal, Assam and adjoining tracts. (Prain 1963, Watts 1971). During plant exploration in Assam in October, 1970, some variations in the cultivated types of this species were collected and the collections were subsequently grown during the winter season (*rabi*) each year. This note briefly records the observations on its growth etc. in Delhi conditions and emphasizes on its possible utility as a leaf vegetable in other areas of India.

The crop is raised during winter. In the Delhi area, seeds were sown in October. The plants picked up vegetative growth slowly and attained a height of 40-50 cm by January when flowering started. By February end these grew about 1.5 m in height. The tall mature plants were hardy with rough and hairy stems/branches as compared to the younger soft-stemmed types of three-months growth. The fruits ripened by March-April when the plants started withering.

The collections grown could be segregated morphologically into two lots:

1. *The pigmented types*: with plant parts especially stem and leaf, pinkish green; the plants flowered profusely and were comparatively slow growing and with smaller leaves; and

2. *The non-pigmented types*: with plant parts perfectly green; the plants bore less flowers but were comparatively fast growing, with more leafy growth and bigger leaves.

Plucking of both the tender shoots and leaves for consumption as a green leaf vegetable can be commenced from mid-December onwards upto March. At later stage the mature plant can be fed to cattle.

The tall, erect habit of the plant suggests that it can also be grown as an additional food plant along the margin/border of fields. In Assam and neighbouring tracts, the herb is grown in patches on home-stead land and the natives eat it as a spinach with rice (Watts, op. cit.). No cultivation of this plant, however, exists in other parts of the country, where, except in the drier zone, it deserves a trial both in the plains and hills. Only local types are known in Assam and adjourning areas, no improved types exist.

To get an idea about its nutritive value analysis (on even dry basis) of the young shoots and leaves of green-stemmed types was arranged in the Division of Biochemistry, I.A.R.I., New Delhi. The plant is seen to be fairly rich in protein and fats (results of leaf analysis on oven dry basis (%): Moisture 82.87; N 3.86; Ca 0.27; P 0.66; ether ext. 3.93; Soluble mineral matter 10.07; insoluble mineral matter 2.91, ash 12.98 and crude protein 24.13.

We are grateful to Shri M. W. Hardas, Head, National Bureau of Plant Introduction for going through this note and offering valuable suggestions.

National Bureau of Plant Introduction,
I.A.R.A., Campus,
New Delhi-110012,
August 26, 1976.

R. K. ARORA
R. PRASAD

References

Prain, D. (1963): Bengal Plants, Vol. I. (reprint ed.).

Uphof, J. C. Th. (1968): Dictionary of Economic Plants, Verlag Von J. Cramer.

Watts, G. A. (1971): Dictionary of the Economic Products of India: Vol. 5, (Reprinted).

32. LECTOTYPE OF *MAESA CASTANEIFOLIA* MEZ (MYRSINACEAE) AND A NEW ADDITION TO THE INDIAN FLORA

(*With a text-figure*)

C. Mez [Pflanzenr. 9 (IV. 238): 44. 1902] described a new species *Maesa castaneifolia*, from the province of Yunnan based on the collections of Henry 9464, 9464A and 11625 and these collections were deposited at the Berlin Herbarium. Mez (l.c.) did not designate the holotype and the above cited specimens are considered as syntypes. Unfortunately these specimens were lost during the Second World War (H. Sleumer, Kew Bull.

Fig. 1. *Maesa castaneifolia* Mez
A. Plant; B. Corolla with stamens; C. Calyx with pedicel; D. Stamen; E. Pistil.

1949: 172-175. 1949). Henry's duplicate collections are available at the Central National Herbarium and it is proposed to designate *Henry* 11625 (CAL) as the Lectotype of *Maesa castaneifolia* Mez. On critical study of several unidentified herbarium specimens at the Central National Herbarium, it is seen that this species occurs in Sikkim and Assam in Eastern India and incidentally is being reported for the first time in the Flora of India. The nomenclature and distribution of the species is given below. An illustration of the species is given for the purpose of ready identification as Mez (l.c.) did not provide any diagram of this species.

Maesa castaneifolia Mez in Pflanzenr. 9 (iv. 238): 44. 1902. [Lectotype Henry 11625 *Collector* (CAL).

Distribution: INDIA: Assam, Golaghat, Feb. 1891, *G. Mann.* s.n. (CAL); Ibid. *Dr. King's Collector* s.n. (CAL); SIKKIM: Mungpoo, *Sine Collector* (CAL).

CENTRAL NATIONAL HERBARIUM,
BOTANIC GARDEN P.O.,
HOWRAH-711103,
December 24, 1976.

M. P. NAYAR
G. S. GIRI

33. *ALYSICARPUS OVALIFOLIUS* (SCHUMACH.) J. LEONARD— A NEW RECORD FOR INDIA

(*With a text-figure*)

Alysicarpus ovalifolius was collected while surveying different areas of Gujarat state, for species of *Alysicarpus* for cytological studies. The species is not recorded in floristic works of India. In this note we report the occurrence of this interesting species for the first time.

Alysicarpus ovalifolius (Schumach.) J. Leonard in Bull. Jard. Bot. Brux. 24:88, fig. 11 (1954)—Verdc., Fl. Zam., Kirkia 9 (Part II):7547, (1974).

= *Hedysarum ovalifolium* Schumach., Beskr. Guin. pl. 1359, (1827).

Erect or spreading herb reaching 20-50 cm in height, branches rooting at nodes with longer internodes, pubescent, later almost glabrous. Leaves unifoliolate, leaflets eliptic to oblong, 1-6 cm long, 0.9-1.0 cm broad, acute and mucronulate at the apex, base subcordate, finely puberulous on the nerves beneath; Petioles 0.5-1.5 cm long, channelled on the upper side; Stipules lanceolate, 0.6-1.2 cm long, striate and acuminate. Inflorescence terminal or leaf opposed lax racemes with usually seven pairs of flowers; peduncles 2.5-3.5 cm long; pedicels 1.0-2.0 mm long; bracts ovate to lanceolate 4.0-5.0 mm long, 1.5-2.0 mm broad, acuminate deciduous. Calyx puberulous, tube 0.8-1.2 mm long, teeth narrow 3.5-4.5 mm long; 0.5-1.0 mm broad. Corolla excluded, standard pink to orange buff, 4.0-5.0 mm long, 3-4 mm wide, wings purplish, keels pale pink. Stamens diadelphus. Ovary pubescent, style (1|3 from its base) bearded with long hairs. Pods 1.0-3.0 cm long, exerted, joints 5-7, flattened, 2.0-3.0 mm long, 1.5-2.0 mm wide with raised reticulate ridges, puberulous. Seeds brown, ellipsoid, slightly compressed with reddish black patches.

Fig. 1. *Alysicarpus ovalifolius* (Schumach.) J. Leonard.

The plant was found growing in the University Campus and Laxmi Vilas Palace compound at Baroda.

Flowering time: August—September.

Fruiting time: September—October.

Herbarium specimens Nos.: S-112, 113, 114, 115, 116.

Critical notes: *Alysicarpus ovalifolius* (Schumach.) J. Leon. is widespread in tropical Africa, Madagascar and Asia (See Verdcourt, Kirkia 9 (Part II): 548 (1974). It resembles *A. vaganalis,* but differs from it in being an annual, having laxer inflorescences with longer distance between the pairs of flowers.

We grateful to Dr. R. M. Polhill, Royal Botanic Gardens, Kew, England, for confirming the identification of the plant.

DEPT. OF BOTANY,
FACULTY OF SCIENCE,
M. S. UNIVERSITY,
BARODA (INDIA),
February 2, 1977.

M. SANJAPPA
R. P. BHATT

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Editors: J. C. Daniel, P. V. Bole & A. N. D. Nanavati

AUGUST 1978 Rs. 35

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Prater, S. H. (1948): The Book of Indian Animals. Bombay. Titles of papers should not be underlined.

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EDITORS,
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1978 AUGUST Vol. 75 No. 2

DISTRIBUTION OF BIRDS IN RELATION TO VEGETATION ON THE NEW DELHI RIDGE[1]

A. J. GASTON[2]

(*With two text-figures*)

The resident, breeding, and wintering avifauna of an area of 0.7 Km^2 of woodland and scrub on the Delhi ridge was studied over a period of three years. The paper describes four main vegetation types, and their distribution in relation to topographic and biotic factors. The bird species found in each are listed.

Species diversity was found to be greatest in dense scrub, the vegetation type least affected by human interference. Species diversity in all habitats was found to be greater in winter than in summer.

The ratio of passerines to non-passerine species was found to be higher in winter than summer.

Turnover of species between winter and summer was found to be highest in woodland habitats, and this may reflect the preponderance of summer visitors amongst the woodland avifauna of the Palaearctic.

Habitat specialisation was found to be greater among non-passerines, but the degree of specialisation was equal when resident passerines were compared with wintering palaearctic passerines.

INTRODUCTION

This paper deals with the ecology of birds on the New Delhi Ridge, describing the vegetation of the area and the distribution of birds in relation to the different vegetation types. Studies were carried out during the period from August 1971 to June 1974 in an area of reserved forest immediately to the west of Rashtrapati Bhavan. Observations were concentrated in about 1 km^2 of broken, rocky terrain, rising gradually from East and West and bounded to the west by Upper Ridge Road, which roughly follows the crest of the ridge, to the north by Shankar Road and to the south by the edge of Buddha Jayanti Park.

There is no previous work dealing specifi-

[1] Accepted May 1977.

[2] Edward Grey Institute, Dept. of Zoology, South Parks Road, Oxford, England.

cally with the birds of this area, but it is frequently referred to in Hutson's "The Birds about Delhi" (1954), which describes the status around Delhi of most of the species recorded in the present study. A comparison with Hutson's records, and also with the status as described in "The Birds of Delhi and District, Field Check List" (1967) provides much useful information, because many species which are to be seen throughout the year in the moist riverain areas along the River Jumna, 4 miles to the East, occur only at certain seasons in the dry scrub of the ridge.

The data on which the present analysis is based consists of field notes taken during the course of research on *Turdoides* spp. As a result, observations were not systematic, but resulted from casual notes on habitat and feeding niches. Field notes did not specify the four categories of vegetation defined below, but usually consisted of a general description of the vegetation in which the species was encountered. Notes on feeding situations were not always included and these have been filled out from memory. Species were described as residents or summer visitors on the basis of seasonal records summarised elsewhere (Gaston 1978). Only resident species recorded in the study area in at least thirty weeks and summer and winter visitors recorded in at least fifteen weeks during the three years of the study are included. Avian nomenclature follows Ali & Ripley (1968-74) and botanical nomenclature follows Maheshwari (1963).

STRUCTURE AND VEGETATION OF THE STUDY AREA

A description of the vegetation of the Delhi area is given by Maheshwari (1963), and both he and Donahue (1967) briefly describe the geology and ecology of the Delhi ridge.

The coarse quartzites which form the underlying rocks of the ridge are the Northernmost extension of the Aravalli Hills, which reach moderate elevations in Rajasthan. Although the overall form of the ridge is gently rounded, it is cut by several deeply incised watercourses. These carry water only during rainy season.

Within the study area the ridge reaches a height of 260 m above sea level in the west, sloping to 230 m in the South-East where it is still 60 m above the level of the River Jumna. A profile taken roughly WNW-ESE across the area (Fig. 1) shows it to be stepped, 2 sloping zones being separated by a more or less level one, which may be the result of a structural weakness. The 2 major watercourses are incised in the sloping zones, but meander without incision in the level area. Soil accumulates principally in the level area, and consists of a coarse alluvial sand with a low humus content.

The development of the vegetation is controlled both by the slope, with its effect on the accumulation of soil, and by biotic influences, particularly grazing and wood-chopping.

The effect of biotic factors on the development of vegetation seems to be greatest in the northern part of the area, adjoining Shankar Road. This part is particularly frequented by people in search of firewood. The least disturbed vegetation occurs in the South-West corner of the area.

Fig. 2 shows the distribution of closed canopy woodland within the study area. The broad belt of woodland running through the centre of the area coincides roughly with the extent of the level shelf, and its consequent accumulation of soil. A second alluvial area, in the North-East corner, lies at the foot of the lower slope.

The trees making up the woodland belt increase in species diversity from North to South,

presumably along a gradient of decreasing biotic interference. The dominant species throughout is *Prosopis juliflora*. In the North this is mixed only with *Albizzia* sp. which was probably planted along Shankar Road, but towards the South there is a progressively greater admixture of *Acacia senegal, Acacia leucophloea, Acacia modesta, Prosopis spicigera*, and *Cassia fistula*. The woodland ranges in height from 6-18 m.

A gradient of species diversity is also noticeable in the composition of the woodland shrub layer. The dominant species throughout is *Adhatoda vasica*, mixed in the North with *Capparis sepiaria*. Towards the South there is an increasing amount of *Carissa spinarum, Grewia tenax, Flacourtia indica*, and *Maytenus senegalensis*.

The sloping areas are characterised by the outcropping of much bare rock. In the North they support only scattered trees, mainly *Prosopis juliflora*, and the perennial vegetation is dominated by stunted clumps of the prickly *Zizyphus nummularia*, growing up to 1 m in height. Towards the South-West a taller scrub composed of *Carissa spinarum, Securinega leucopyrus, Dichrostachys cinerea, Zizyphus mauritiana*, and *Flacourtia indica* develops with scattered patches of *Anogeissus pendula* woodland, up to 5 m high. *Butea monosperma*

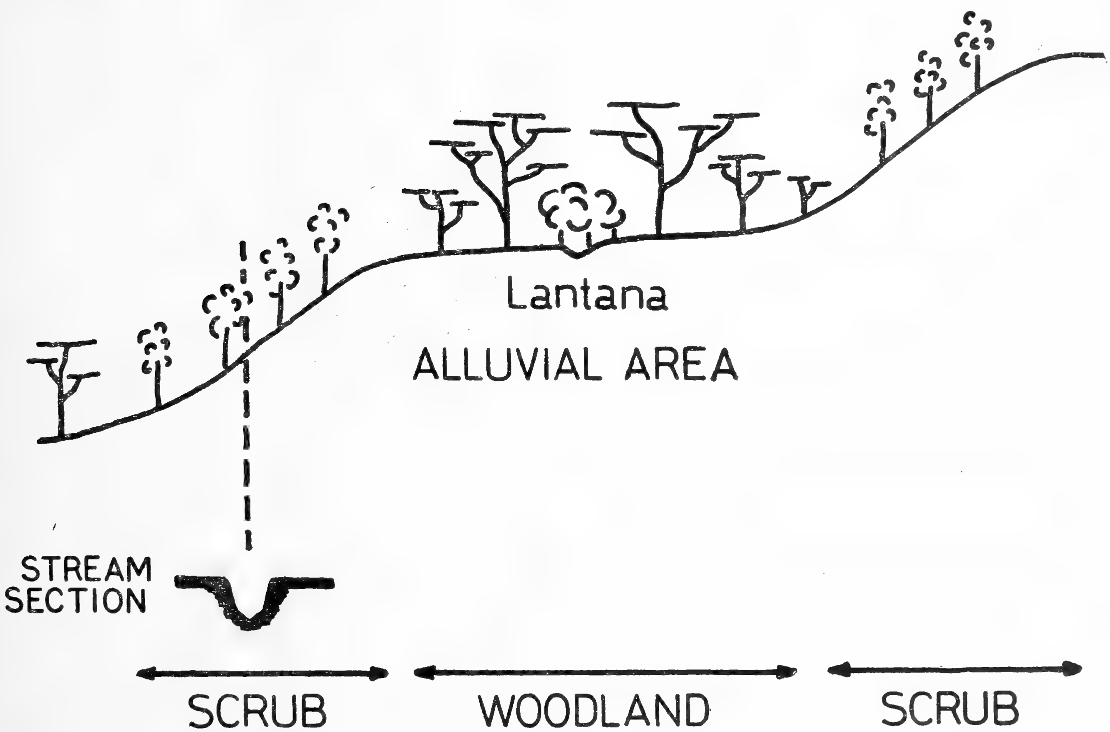

Fig. 1. Section WNW-ESE across the Ridge study area showing generalised pattern of vegetation in relation to slope. Vertical scale greatly exaggerated.

occurs commonly, scattered throughout this area, growing up to 8 m high, but nowhere forms dense stands.

Other shrubs which occur in localised patches are *Jatropha gossypifolia,* which grows on steep rocky places, and *Balanites roxburghii,* which grows in the level zone on the margins of the woodland, and apparently requires some depth of soil. Several dense clumps of *Lantana indica* occur where watercourses cross the level zone, and this shrub seems to prefer a combination of perennial moisture and some soil accumulation.

The herbaceous vegetation of the study area flourishes almost exclusively during the rainy season, which lasts from July to October. During this period open areas become clothed in grasses and other herbs, and shrubby perennials such as *Hibiscus micranthus* and *Tephrosia* spp. put out luxuriant growth.

Avian habitats

Four main vegetation types can be recognised in the study area as providing distinct habitats for birds:

1) Closed canopy woodland with an open understory, mainly of *Adhatoda vasica.*
2) Closed canopy woodland with a dense understory of *Carissa spinarum, Capparis sepiaria,* and *Lantana indica,* as well as *Adhatoda.*
3) Dense scrub with *Carissa spinarum, Securinega leucopyrus, Dichrostachys cinerea,* and *Anogeissus pendula* up to 3m high, with scattered *Butea monosperma.*
4) Low scrub dominated by *Zizyphus nummularia,* up to 1 m high, with scattered *Prosopis juliflora,* up to 5m high, and many bare rocky outcrops which support an ephemeral flora during the rains.

The distribution of these 4 vegetation types is shown in Fig. 2.

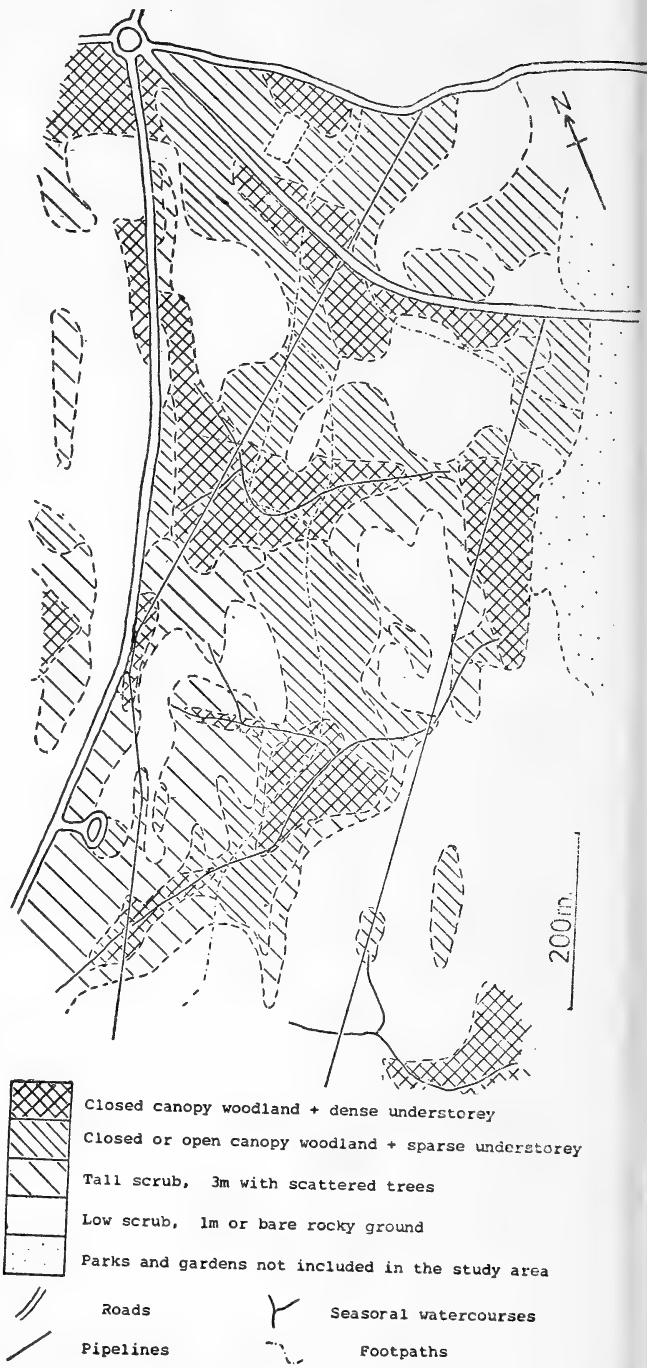

Fig. 2. Map of the Ridge study area showing the distribution of different vegetation types.

TABLE 1

DISTRIBUTION OF BREEDING BIRDS AND WINTER VISITORS AMONG FOUR DIFFERENT VEGETATION TYPES ON THE NEW DELHI RIDGE

Residents (R) & Summer visitors (SV)	Woodland + open understory		Woodland + dense understory	Tall scrub + *Butea*	Open scrub	Total types
Accipiter badius R	+		+	+		3
Butastur teesa SV	+			+		2
Francolinus pondicerianus R				+		1
Pavo cristatus R	+	G		+		2
Vanellus indicus SV					+	1
Burhinus oedicnemus R					+	1
Streptopelia decaocto R	+	G		+	+	3
S. tranquebarica SV	+	G	+			2
S. senegalensis R				+	+	2
Psittacula krameri R	+	C	+	+		3
P. cyanocephala R				+		1
Clamator jacobinus SV	+	SC	+	+	+	4
Cuculus varius SV	+	C				1
Eudynamys scolopacea SV		SC	+			1
Taccocua leschenaultii R				+		1
Centropus sinensis R		GS	+			1
Caprimulgus asiaticus SV				+		1
Merops orientalis R				+	+	2
Coracias benghalensis SV					+	1
Upupa epops R	+	G				1
Megalaima zeylanica SV	+	C	+			2
M. haemacephala SV	+	C	+			2
Dinopium benghalense R	+	T	+			2
Dendrocopos mahrattensis R	+	T	+	+		3
Mirafra erythroptera R					+	1
Lanius vittatus R	+	G		+		2
Lanius schach R				+		1
Dicrurus adsimilis SV	+			+		2
Sturnus pagodarum SV	+	G				1
Acridotheres tristis SV	+	G				1
Dendrocitta vagabunda R	+	SC	+	+		3
Corvus splendens R	+	CG		+		2
Tephrodornis pondicerianus R	+	C	+	+		3
Pericrocotus cinnamomeus R	+	C	+			2
Pycnonotus jocosus R		S*	+	+		2
P. leucogenys R				+	+	2
P. cafer R	+	SC	+	+	+	4
Chrysomma sinensis R		S*	+	+		2
Turdoides caudatus R				+	+	2
T. malcolmi R	+	G			+	2
T. striatus R	+	GT	+	+		3
Prinia hodgsonii R	+	SC	+	+		3

Residents (R) & Summer visitors (SV)	Woodland + open understory		Woodland + dense understory	Tall scrub + *Butea*	Open scrub	Total types
P. buchanani R				+	+	2
P. subflava R				+		1
P. socialis R		S	+	+		2
Orthotomus sutorius R	+	ST	+	+		3
Copsychus saularis R		G	+			1
Saxicoloides fulicata R	+	G	+	+	+	4
Nectarinia asiatica R	+	SC	+	+		3
Zosterops palpebrosa R	+	SC	+			2
Passer domesticus SV	+	C		+		2
Petronia xanthocollis SV				+	+	2
Lonchura malabarica R				+	+	2
Winter visitors						
Elanus caeruleus				+	+	2
Jynx torquilla				+		1
Lanius excubitor					+	1
Pericrocotus ethologus	+	C	+			2
Muscicapa parva	+	C	+			2
Sylvia hortensis		S	+	+		2
S. curruca	+	SC	+	+		3
Phylloscopus collybita	+	GSC		+		2
P. griseolus	+	GT	+	+		3
P. inornatus	+	C	+			2
P. subviridis	+	C	+			2
Phoenicurus ochruros	+	G	+	+		3
Turdus ruficollis		GS*	+	+		2
Carpodacus erythrinus				+		1
Emberiza stewarti				+	+	2

Woodland feeding zones: G; Ground T; Trunks S; Shrubs C; Canopy
*; species associated particularly with dense stands of *Lantana indica*

TABLE 2

THE NUMBER OF BIRD SPECIES FOUND IN EACH VEGETATION TYPE

		Non-passerine	Passerine	Total	Resident	Ratio Res/ Nonres.
(1) Woodland + open understory	Summer	13(43%)	17(57%)	30	20	1.11
	Winter	7(25%)	21(75%)	28		
(2) Woodland + dense understory	Summer	10(42%)	14(58%)	24	19	1.35
	Winter	5(18%)	23(82%)	28		
(3) Dense scrub	Summer	13(37%)	22(63%)	35	29	1.81
	Winter	12(31%)	27(69%)	39		
(4) Open scrub	Summer	7(47%)	9(53%)	16	12	1.5
	Winter	6(33%)	10(67%)	16		

Distribution of bird species in relation to vegetation types

Because of the small size of the study area relative to the mobility of most birds, practically all species were seen in all 4 vegetation types at one time or another. Table 1 shows the distribution of nesting and wintering species among the vegetation types, judged on the basis of their preferred feeding habitats during the breeding season (resident species and summer visitors) or winter (winter visitors). Resident species generally seem to move about more outside the breeding season, when food is probably least abundant.

Species found in the 2 woodland vegetation types are further classified according to their preferred feeding niches; ground (G), shrub (S), trunk (T) and canopy (C). Those species particularly associated with the occurrence of dense clumps of *Lantana indica* are also indicated.

Omitted from Table 1 are 3 species which occur in the study area only in the vicinity of water: *Halcyon smyrnensis* (resident), and *Erithacus svecicus*, and *Motacilla cinerea* (winter visitors).

Table 2 shows the number of species found in each vegetation type, and the ratios of passerine to non-passerine species. The largest number of species is found in the dense scrub (type 3). This may be because it is intermediate in character between the woodland and the open scrub, but its floristic composition is relatively diverse, and must resemble the original flora of the area more closely than do the other 3 vegetation types.

In all except vegetation type 4, bird species diversity is greater during the winter than during the breeding season. This is due to an influx of passerine species during the winter. While there is a 28% increase in passerines, there is a decrease of 33% in the number of non-passerine species.

The increase in passerine species is most marked in the two woodland habitats which show 24% (1), and 64% (2) increases. The other two habitats show increases of 23% (3) and 11% (4). The numbers of non-passerine species in the two woodland habitats fall by 46% (1), and 50% (2) respectively, while in the other two habitats they decrease by 8% (3) or by 14% (4).

At first sight these figures suggest a replacement of breeding non-passerine summer visitors by passerine winter visitors, but the two groups tend to occupy quite different niches. The majority of passerine winter visitors are small insectivorous birds, and 7 of the 11 found in woodland feed partly or wholly in the canopy. In fact this feeding zone shows a 78% increase in passerines between summer and winter. The non-passerine summer visitors, on the other hand include only two insectivorous species, *Clamator jacobinus* and *Cuculus varius*, among those found in woodland. The rest fall into two categories:
a) frugivorous species: *Eudynamys scolopacea*, *Megalaima zeylanica* and *Megalaima haemacephala*. b) moderate-large insectivorous species found in scrub; *Caprimulgus* spp., *Merops orientalis*, and *Coracias benghalensis*.

Seasonal turnover of Species

Thirty-eight species are resident in the study area throughout the year. This number does not include species such as *Pernis ptilorhynchus*, *Milvus migrans*, *Gyps benghalensis*, *Neophron percnopterus*, and *Spilornis cheela* which are seen throughout the year, but which are not known to nest in the area.

Fourteen species are summer visitors, and sixteen winter visitors. The overall ratio of resident: non-resident species is 1.33.

Tabel 2 gives the ratios of resident: non-resident species for the four vegetation types separately. This ratio is lowest in the woodland habitats where turnover of species is highest, and highest in the scrub, where most species are resident. This observation parallels the findings of MacArthur (1959) for 29 stations across North America, where he found the proportion of resident species to be lower in woodlands than in open habitats at the same latitude.

The higher proportion of winter visitors in the woodland around Delhi may be a corollary of the situation which MarArthur found in temperate North America. As more species leave woodland habitats in the temperate zone during the winter they might be expected to seek similar habitat in their winter quarters. The greater turnover in the woodland avifauna around Delhi may not necessarily, therefore, reflect differences in the seasonal abundance of food in different vegetation types.

Local Migrants

Among species classified as summer and winter visitors in Table 1, several are only local migrants, and are found throughout the year in areas adjacent to the ridge. The summer visitors which come in this category are *Butastur teesa, Streptopelia tranquebarica, Merops orientalis, Coracias benghalensis, Megalaima zeylanica, Megalaima haemacephala, Dicrurus adsimilis, Sturnus pagodarum, Acridotheres tristis,* and *Petronia xanthocollis.* This includes all the passerine summer visitors. Among winter visitors *Psittacula cynaocephala,* and *Lanius excubitor* both breed around Delhi, and their presence on the ridge during the winter may reflect a general dispersal at this season.

Table 3

The numbers of bird species occupying 1, 2, 3 and 4 vegetation types

	No. of species occupying x vegetation types				Mean vegetation types/species		Totals
	1	2	3	4			
Passerines—							
Resident	4	12	6	2	2.25		24
Non-resident	3	3	0	0	1.50	1.89	6
Palaearctic winter visitors	2	7	3	0	2.08		12
Non-passerines—							
Resident	7	4	4	0	1.81		15
Non-resident	5	5	0	1	1.62		11
Total	21	31	13	3	1.97		68
	a	b					

Testing the proportion of group a (narrow habitat preference) species to group b species, among both passerines and non-passerines $X^2 = 4.6$, $p < 0.05$. Comparing resident to non-resident species, using passerines and non-passerines combined, $X^2 = 0.44$, $p > 0.5$.

Degree of Specialisation in Habitat Selection

The number of different vegetation types occupied by a species can be treated as a measure of the degree to which the species is specialised in that dimension of its ecological niche. The mean number of vegetation types occupied, calculated for all species, is 1.97. Only two resident species, *Pycnonotus cafer*, and *Saxicoloides fulicata* occupy all four (see Table 3), as does the summer visitor *Clamator jacobinus*.

Passerine species seem to be less specialised in this respect than non-passerines. Among passerines 9 out of 42 species are found in only one vegetation type, while the corresponding proportion for non-passerines is 12 out of 26 ($\chi^2 = 4.6$, $p < 0.05$).

This supports the hypothesis put forward by Klopfer & MacArthur (1960), suggesting that non-passerine birds, being more stereotyped in their behaviour than passerines, occupy smaller niches.

Another suggestion, forming part of the same hypothesis, is that tropical passerines show greater specialisation, and therefore occupy smaller niches than temperate passerines. This is not supported by a comparison of the mean number of vegetation types occupied by resident passerines, with the same index for palaearctic winter visitors. The means are practically identical (2.25, 2.08). The habitat preferences of the resident species are assessed on the basis of their distributions during the breeding season, however, and many species tend to range further afield during the winter. The average resident may actually be less specific in its habitat requirement than the average winter visitor during the period when the two groups co-exist.

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FEEDING, GROWTH AND EARLY DEVELOPMENT OF THE INDIAN TROUT, *BARILIUS* (*OPSARIUS*) *BOLA* HAM.[1]

C. V. KULKARNI[2] AND S. N. OGALE[3]

(*With five text-figures*)

Study of feeding habits, growth and early development of the Indian trout, *Barilius* (*Opsarius*) *bola* Ham. which was introduced in the Lonavla lakes near Poona, indicates that it is a carnivorous fish thriving largely on small fish such as *Rasbora, Chela, Oxygaster, Danio,* etc. In lakes it grows to about 620 g. in 27 months and breeds in the third year. The male develops rough, tubercled scales on the sides and bright coloration on fins during breeding season which begins early in the monsoon.

On hypophysation and stripping, the fertilised eggs took about 65 hours to hatch. The hatchlings had medium sized yolk sac and were comparatively more active than those of major carps and started swimming very soon. The post-larva developed chromatophores only on the fourth day and started feeding on minute *Moina* etc. On the seventh day it reached 8 mm length and on 18th day a well-grown 18 mm fry stage.

INTRODUCTION

Barils or the Barilius group comprising mostly small sized fish have scarcely attracted the attention of fishery biologists in the past. Chacko (1945) wrote a short note on *B. bendelisis,* a tiny form hardly weighing 20 g. when full grown and 12 cm in total length. Day (1878) referred to Indian trout as *Barilius bola* Ham. but Hora (1937) reviewing the taxonomic position of the fish, preferred to call it *Barilius* (*Opsarius*) *bola* Ham. It is the largest species among the group *Barilius* and attains 1.5 kg in weight. It is quite outstanding for several reasons; yet except for a few notes about its angling qualities by Thomas (1897) and Macdonald (1948) and about its suitability for introduction in Lonavla lakes (Evans 1926) and in Peninsular India by Spence & Prater (1932), very little has been said about the breeding habits or early life history of this fish. It was not recorded from anywhere south of the Vindhya hill range in India till its introduction in the Walwhan lake of the Tata Electric Co. at Lonavla, District Poona (Kulkarni 1975). This introduction enabled recording of some of the observations made on this fish and very recently, it could be bred, with the help of pituitary harmone. The eggs and early stages thus obtained are described below.

FEEDING, GROWTH AND BREEDING

Unlike the feeding habits of most of the members of the Cyprinoid group, the *B. bola* is largely a piscivorous form, rejecting all inanimate food in the natural environment. It is largely a riverine fish, frequenting shallow marginal waters for hunting small fish life. In lacustrine conditions, it inhabits the upper columns of the lake waters and feeds voraciously on small live fish such as *Rasbora, Chela, Oxygaster* and *Danio,* but it studiously

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avoids any dead ones among them even in small ponds. This endorses the presumption made by Hora (1937) that "the form and structure of its alimentary canal leaves no doubt that it is a highly carnivorous species". Groundnut cake which is liked by most of the carps is disdained by this fish; neither does it take any green algae in the water. However, the rapacious nature of the fish indicates that it might take to artificial feed of animal origin after certain amount of training, as is found in the case of Murrels.

As regards the rate of growth, no data are available based on commercial catches but it can be stated that the fish could grow to about 620 g in 27 months in the large open water of Walwhan lake, which has a water spread of 556 ha. This growth is based on the actual recoveries of specimens from the lake which was stocked with fingerlings obtained from tributaries of Chambal river in northern India in 1974 (Kulkarni 1975).

Breeding: From observations which have been reliably reported, the fish approaches running streams for the purpose of breeding in the early months of the monsoon (June) but prefers quieter inundated areas by the side of such freshets for spawning where they were actually seen in nuptial movements. A pair which was captured contained ripe eggs and oozing milt; they would have probably spawned in that area had they not been roughly handled by their captors. This habit of approaching freshets shows considerable similarity between them and other large carps like Rohu, Mrigal etc. Taking into consideration its age at the time of introduction, the fish can be said to breed in the third year of its age and in the early part of the monsoon, the aforesaid mature pair of fish having been encountered in the last week of June 1977. Chacko (loc. cit.) reports breeding of *B. bendelisis* from July to December in tributaries of Krishna and Cauvery.

In respect of secondary sexual characters in *B. bola,* there are no structurally clear cut differences, but in the male, scales on the sides of the body, particularly the posterior half of it become rough during the spawning season; so much so that it enables distinguishing the sexes by mere touch and without removing the fish out of the water. The roughness was found to be due to a wart like concretion in the middle of the exposed part of the scale (fig. 1) and it disappears after the spawning season. Secondly, the outer rays of the lower lobe of the caudal fin are distinctly pink in colour in the male while they are of lighter shade in the female. The pectoral, pelvic and anal fins are yellowish orange in the male and lighter in female. Further the dark spots on the opercles are much more prominent in the male. In short, like many other animals the male shows his best colouration during this season. In the case of *B. bendelisis* also the

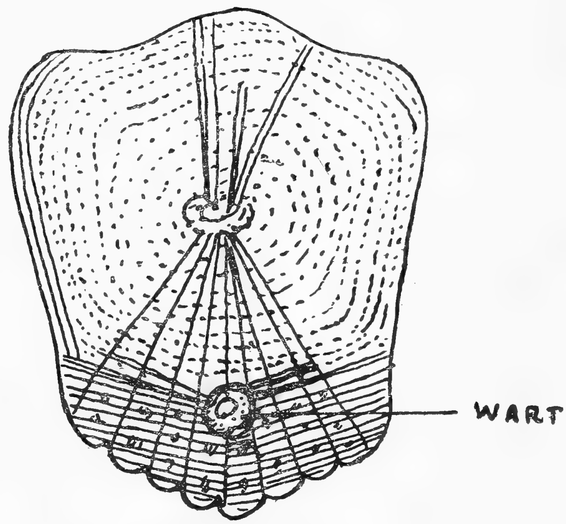

Fig. 1. Scale from male *Barilius* (*Opsarius*) *bola.*

males are reported to be more brightly coloured and have tiny tubercles on both jaws (Chacko, op. cit.), but no rough scales on the body are mentioned.

Some of the Indian trouts were grown in a pond for ascertaining whether they would breed naturally like *Cyprinus carpio*. This expectation was, however, belied, though two females weighing 400 gm appeared spent in the first week of July. The remaining three females though they were small in size, being hardly between 260 and 300 gm in weight and in the second year of their age were injected with extracts of pituitary glands at the rate of 2 mg per kg of body weight at 7 a. m. on 8-vii-1977. The first injection was followed by a second one at 4 mg per kg body weight, four hours after the first injection. The males were given only one dose of 2 mg per kg per body weight along with the second injection to the females and the both sexes put together in the breeding enclosure (hapa). Temperature of water varied between 21° and 22°C as intermittent showers and cloudy skies continued all along. As no natural spawning occurred even after seven hours after the second injection, the females were stripped by dry method and the eggs fertilised with the help of milt similarly obtained from the males. After washing the eggs in the usual manner, they were found to be absorbing water and also indicating normal fertilisation, thus ensuring success in breeding the Indian trout artificially, for the first time.

Eggs and early development

Eggs: The egg of the Indian trout, when freshly laid is about 1.5 mm and on absorbtion of water is 2.8 mm in diameter (Fig. 2a). Being slightly heavier than water it settles at the bottom in still water but with slightest disturbance or movement it moves along with the water like the eggs of other large carps (Rohu, etc.). It is spherical and almost transparent except at the yolk portion which is dull creamy in colour. The perivetelline space is somewhat narrow as compared to that in the large carps.

The eggs were observed at an interval of every four hours in the early stages. They passed through the usual cell divisions and the blastula stage, including the elevated blastoderm on the germinal pole of the yolk mass which flattens later on and gives rise to the embryonic shield and also the cephalic groove (Fig. 2b, c, d).

At 18 hrs, the development of the embryo had progressed considerably, the size of the yolk mass reduced and the cephalic area and tail end became distinct thus representing a coma shaped stage (Fig. 2d). The temperature of water in which the eggs were hatched varied from 26 to 28°C.

At 24 hrs, the head region seems to have developed fairly fast; the optic vesicles were seen and also a few myotomes in the body region. The yolk mass had been further absorbed and the tail end had been free. At intervals slight movement of the embryo was also perceptible within the eggs. The stage of development in all eggs of the same batch was not the same, some having lagged behind even in the same water temperature.

At 36 hrs, the yolk mass was further reduced and the development of the embryo progressed internally in respect of additional myotomes, cerebral lobes and other organs. The embryo started twitching and moving within the egg shell, the rate of such movement being as much as 30 to 38 times per minute. However, at this stage the development became considerably uneven in other eggs of the same lot.

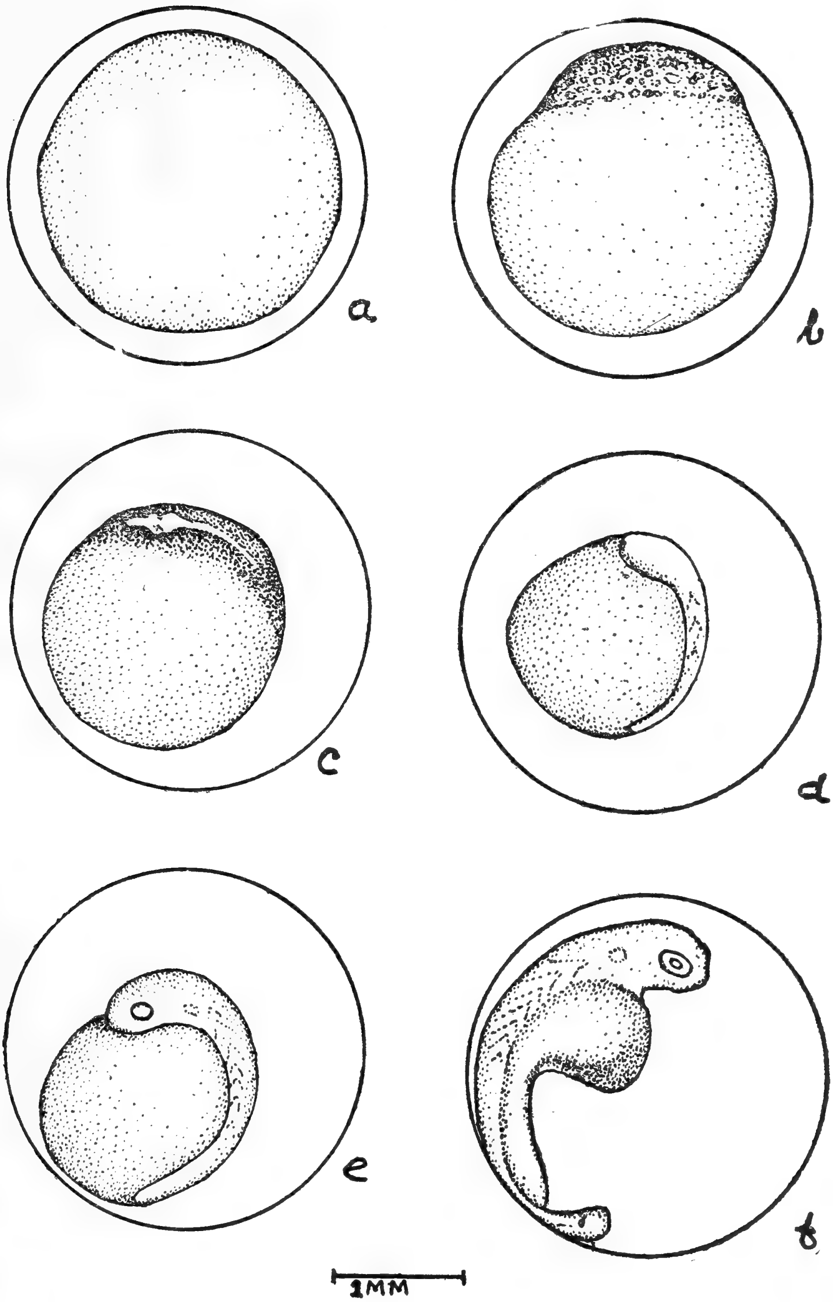

Fig. 2. a. Newly fertilised egg of Barilius (*Opsarius*) *bola* Ham.
b-f. Developing stages of eggs of *B.* (*O.*) *bola* (Ham.)

At 42 hrs, the twitching action of the body of embryo continued vigorously. The head region and the cerebral lobes had developed distinctly. The optic vesicles and the optic lens were clearly visible but no chromatophores were perceptible. The muscle segments and the yolk sac of the embryo with its anterior rounded portion and the posterior tubular portion and also the caudal lobe were clearly observable. The heart tube was indistinctly seen and as the demarkation was not clear, pulsation of the heart had not commenced. However, after three hours heart formation became apparent and feeble pulsation could be watched. The eyeball was distinct and glistening, but no pigment was seen. The optic capsules had developed though otoliths were yet absent. For better oxygenation of water the eggs were kept in a petridish, with an electric fan kept going all the time. This had also helped in maintaining the temperature of water at 26°C. The embryo continued to develop its organs and to wriggle around within the egg case with moderate jerking movements of the tail.

At 11 a.m. on 11-vii-1977, i.e. 64 hours after it was fertilised one of the eggs hatched into first hatchling or a larva with a prominent yolk sac (fig. 3). It measured 5 mm in total length, whitish grey in colour, with double lobed yolk sac slightly silver grey. The anterior portion of the yolk sac though rounded was a slightly oblong while the posterior one was more elongated with a wide notch or constriction between the two. The length of the yolk sac (both lobes) was almost half of the total length of the larva. The rudiments of jaws were indistinctly perceptible.

The black pigment in the eyes had fully developed. The eyes appearing distinctly large and black. Similarly the heart also was fully formed and pulsating and the blood corpuscles had become red as usual. Auditory capsule with otoliths in them were perceptible. No large chromatophores were seen on the head or the body except a row of small elongated dash like black pigmented streaks above the dorsal side of the yolk sac. Very thin pectoral fin fold was seen with no rays in it. The vertical median fin fold starts dorsally slightly anterior to the mid point of the yolk sac and continues around the caudal end, terminating near the position of the anal opening. Second vertical fin fold is seen on the posterior portion of the yolk sac and proceeds backwards to end near the expected anal opening. As compared to the hatchlings of other large carps which are rather semi quiescent, settling at the bottom and only occasionally twitching and wriggling, the hatchling of the Indian trout is more developed and starts swimming about as soon as it is hatched. The earlier helpless condition common in large carps is probably passed in this case in the egg stage itself.

After about 30 hours of hatching, i.e. on the second day, the length of the hatchling had not extended beyond 6.2 mm but jaws which were rudimentary were well formed and even moveable. The eyes had become more prominent with a well formed pale golden ring around the lens. The heart was vigorously pulsating and the division between the anterior and posterior portions of the yolk sac had further progressed leading to a constriction. The anterior one shorter and the posterior elongated. The tail end is slightly up turned. There were yet no chromatophores on the head or the body, except the small fine dots on the upper side of the yolk sac.

On the fourth day, the hatching becomes quite active and the movements of its jaw indicated its attempts to feed on small food particles. Small sized *Moina* sp. sifted through a strainer was supplied to these hatchlings and it was found that they did attack

them and thus feed on them. The hind gut had also developed along with its opening. The pectoral fin fluttered actively. At this stage large chromatophores had developed on the head and dorsal portion of the body above the pectoral and a few behind it. Smaller melanophores were seen above the anterior portion of the yolk sac which was considerably reduced in size, its posterior portion had almost been tube-like and functional.

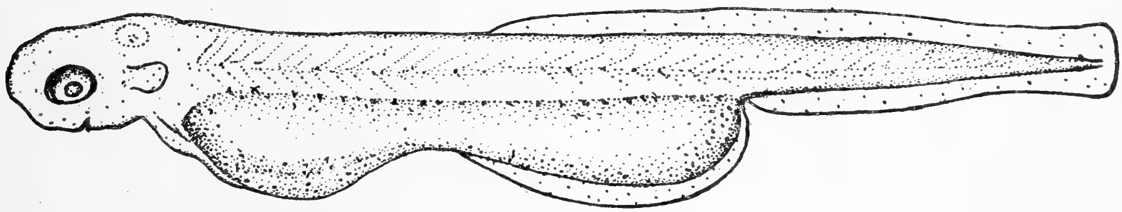

Fig. 3. Newly hatched larva (hatchling) of *B.* (*O.*) *bola* Ham.

On the seventh day, the hatchling (fig. 4) had almost become a tiny fry of 8 mm length. The body was covered with large number of chromatophores right from the head to the tail portion. The yolk sac had completely disappeared and portion of intestinal tube was visible so also a small air bladder. The dorsal and caudal fin folds were developing fin rays but there were no traces of anal or pelvic fin rays. The preanal fin fold was also reduced in size. The fry continued to feed on sifted *Moina* and moved about elegantly.

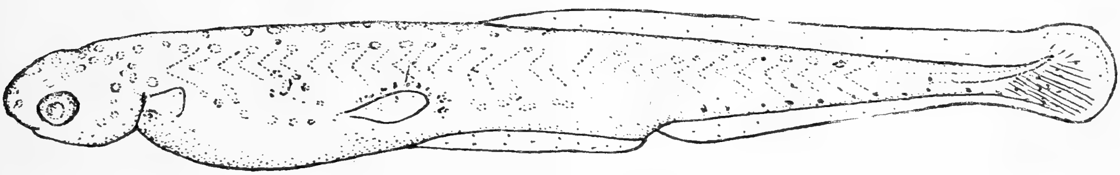

Fig. 4. Seven day old fry of *B.* (*O.*) *bola* Ham.

On the seventeenth day, the fry (fig. 5) had reached total length of 18 mm with all the fins well developed. The body continued to be covered with melanophores scattered all over as in the earlier stage. They appeared even on the caudal fin-rays and a part of the caudal peduncle. The nature of the jaws, prominent eyes and sleek elongated body were character-

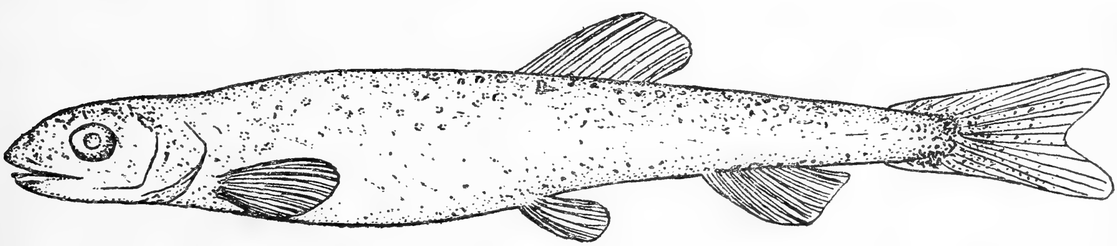

Fig. 5. Seventeen day old fry of *B.* (*O.*) *bola* Ham.

istic of the adult Indian trout. However, it is felt that the large number of melanophores seen at this stage may be due to captive condition and is likely to be much less in natural open bodies of water.

It was seen that the rate of development of embryos was different in individual cases. Although the first egg hatched out in 64 hrs, other eggs in the same batch took 68 to 72 hours in water of 26°C. Further, the eggs which were being hatched in floating trays with continuous sprinklers of water of 21° - 22°C at Lonavla (Walwhan) hatchery, the hatching period varied from 58 to 68 hours, some of them taking even longer time. In these floating trays a large number of eggs perished on account of some unidentified infection. Hence 68 hours can be taken as average hatching period. It was further seen that these eggs were more delicate than the eggs of other carps and easily susceptible to disease.

Acknowledgements

We express our indebtedness to the Tata Electric Companies for affording necessary facilities for conducting the studies embodied in this paper at their Walwhan (Lonavla) fish farm. Our sincere thanks are also due to Dr S. N. Dwivedi, Director, Central Institute of Fisheries Education, Versova, Bombay 400061, for providing laboratory facilities and to Shri P. N. Roy for deligent attention, preliminary drawings.

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FLORISTIC COMPOSITION AND SEASONAL PATTERN OF VEGETATION OF PINE FORESTS OF SHILLONG IN MEGHALAYA[1]

R. R. RAO AND P. KHARKONGOR[2]

(*With a text-figure*)

INTRODUCTION

Assam, one of the richest and interesting 'Botanical Provinces' of India is still botanically incompletely known. This is more so with Khasi hills in Meghalaya which is predominantly occupied by pine forests. These pine forests shelter a host of other species. The ecology and phytosociological aspects of these are little known. Even the floristic composition of these forests remains unknown.

The only regional account of the flora is that of Kanjilal *et al.* (1934-40) which is incomplete and has a strong bias towards the woody forest species. Though collections have been made since the time of Hooker (1872-97), a consolidated flora of this region is lacking.

A series of studies on the flora of Shillong have been undertaken by the North-Eastern Hill University at Shillong and the present account deals with the floristic composition of pine forests of Shillong in Meghalaya.

Location and soil:

Shillong is situated at 25°34′N, 91°56′E. Physiographically the entire area is hilly with a luxuriant growth of pine forests (*Pinus kesiya*). The altitude varies from 1250 to 1960 m.

The soil is fertile, loamy and dark-brown. In many places it is acidic with pH ranging from 6.1 to 6.9.

Climate and Rainfall:

Shillong has a cool climate. As it is evident from the graph[3] (Fig. 1), winter temperatures go down to 5.2°C in the month of January and maximum temperature is observed in the month of April at about 25.5°C.

Rainfall is spread over all the months except December. The average total rainfall recorded for the period between 1972-74 is 219.86 cm.

During December-January frost occurs on some days in the early mornings and this kills almost all the herbaceous vegetation, leaving the ground bare and covered with a mat of pine needles.

Previous work and present approach:

The area under study is floristically incompletely known, though systematic collections have been made ever since the time of Hooker (1872-97). The only flora which covers this part is that of Kanjilal *et al.* (1934-40), which is more a forest flora. Besides, except for Poaceae by Bor (1940) the monocot part is not treated. Mitra (1958) has given an account of the monocotyledonous plants of NE. region.

Though this area has received much attention, after the establishment of the regional

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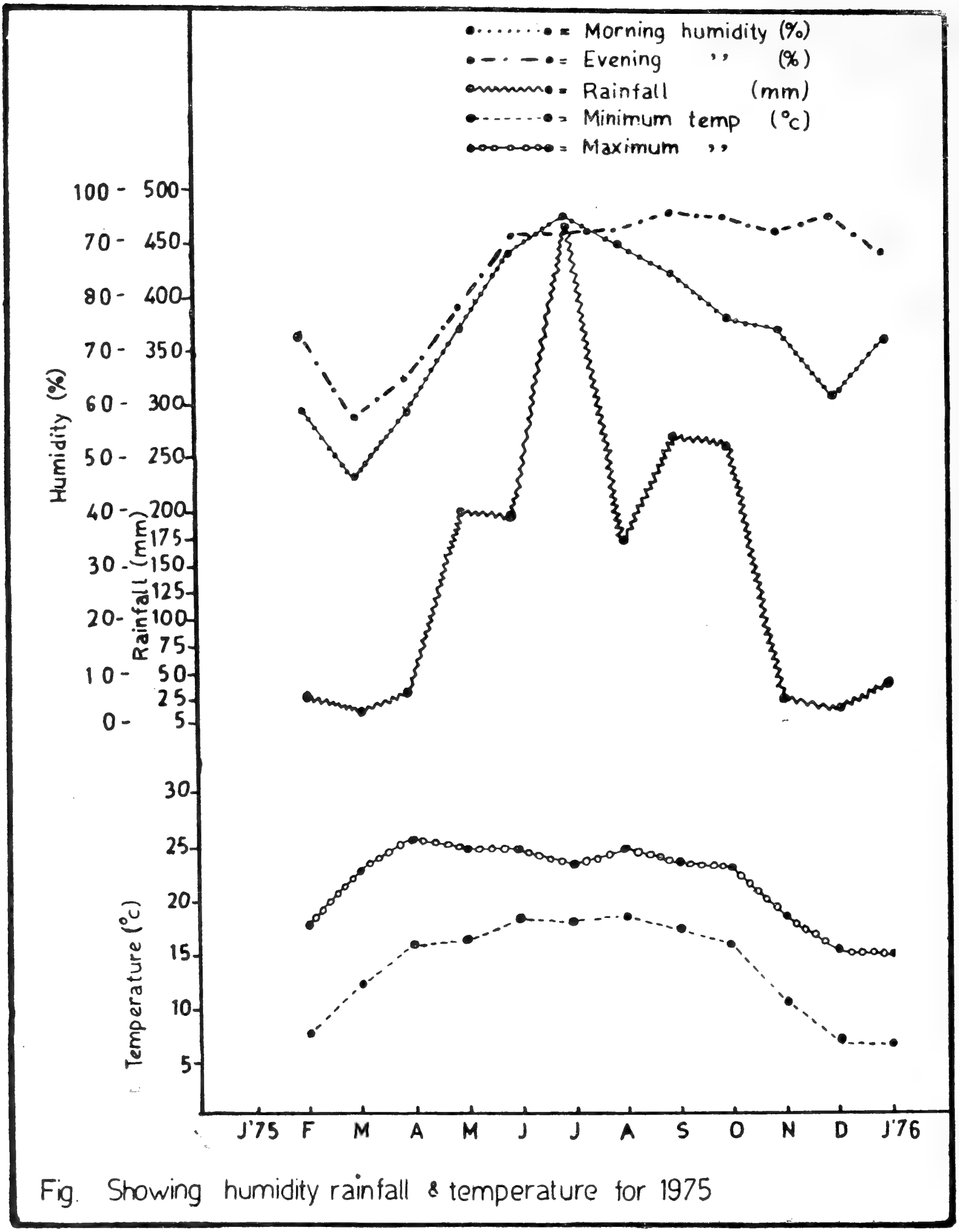
[3] Meteorological data for the year 1975. Thanks are due to the Meteorologist-in-charge, Khasi hills, Shillong for the meteorological information.



Morning humidity (%)
Evening ,, (%)
Rainfall (mm)
Minimum temp (°c)
Maximum ,,
Humidity (%)
Rainfall (mm)
Temperature (°c)
J'75 F M A M J J A S O N D J'76
Fig. Showing humidity rainfall & temperature for 1975

Fig. 1.

circle of the Botanical Survey of India at Shillong, a consolidated flora of Shillong is still lacking. Except for few publications on the flora of Shillong proper not much is known (Rao & Deka 1970; Rao & Rao 1976). Some significant contributions on the flora of NE. region have been made by various officers of the Botanical Survey of India at Shillong. These include Shillong also (Naik 1964; Rao & Verma 1969; 1970; 1972). The flora of the pine forests, however, remained unexplored.

The present account is based on the collections and study made by us during 1975-77. Plants have been collected from different pine forests in and around Shillong. Care was taken to collect minute herbs and other ephemeral plants. Abundant field notes were made at the time of collection with special reference to their habitats and associates. Normal herbarium procedures were followed in pressing, poisoning and mounting the specimens.

All the collections are deposited in the Herbarium of North-Eastern Hill University, Shillong (*NEHU).

Floristic composition and seasonal pattern of vegetation

Predominantly the forests are of *Pinus kesiya* with trees like *Schima khasiana, Quercus* sp., *Myrica esculenta, Acacia mollissima, Alnus nepalensis* interspersed. The shading by the tree canopy keeps the area moist and offers a suitable habitat for a number of herbaceous species. These cover the ground throughout the year except between November-February the coldest months in Shillong when all the herbaceous vegetation dies. Only the introduced *Eupatorium, E. odoratum, E. riparium* and *E. adenophorum* manage to flourish and resist the severe cold season. *Eupatorium adenophorum* forms the dominant herbaceous vegetation in all pine forests at higher elevations.

Moderately shaded areas support grass-legume association which are subject to grazing and scrapping in some places. The common leguminous species are *Trifolium repens, Desmodium heterocarpon, Crotalaria ferruginea,* and *Smithia blanda.* The other common species which are predominant during monsoon are *Artemisia nilagirica, Lantana camara* var. *aculeata, Plectranthus coetsa, Osbeckia crinita, Hypochaeris radicata, Galinsoga parviflora, Cardamine hirsuta, Eragrostis nigra, Sporobolus fertilis, Polygonum punctatum* and *Centella asiatica. Aeginitia indica,* a member of Orobanchaceae is common in some forests among pine litters during August-October.

The severe cold of November-January checks and kills the growth of these herbaceous species, and only the hardier species like *Lantana camara* and *Eupatorium* manage to survive. In early March, *Eupatorium adenophorum* and *E. riparium* produce profusely their white flowers and form a conspicuous feature of the vegetation.

Though forest fires are not common in these forests, less densely wooded areas covered with grasses often readily catch fire and this again kills all the herbaceous species, and young shoots of the perennial species.

In marshy areas and along the ravines hydrophytes and marsh plants like *Eriocaulon brownianum, Lindernia cordifolia, Rotala rotundifolia, Lobelia colorata, Smithia blanda, Polygonum capitatum* and *Impatiens chinensis* and many sedges are very common. *Brugmansia suaveolens* with large, pendent, white flowers forms a striking feature of vegetation all along the streams in Shillong.

* The abbreviation NEHU is yet to find a place in *Index Herbariorum.*

Enumeration of the species of pine forests

In the following enumeration, the families, genera and species under each family are alphabetically arranged. Common synonyms are given in brackets immediately after the valid names. Vernacular names (Khasi names) are given where available; followed by brief notes on each taxon and its common associates. Flowering and fruiting period is also shown and this refers to our collections studied.

Species not mentioned by Kanjilal *et al.* (1934-40) are indicated by an asterisk. This does not refer to monocots except for Poaceae.

Acanthaceae

Hypoestes triflora R. & S.

Herb in shady places, associated with *Eupatorium adenophorum* and *Galium rotundifolium;* sparse. Fls. Sept.-Oct. *Kharkongor* 582.

Strobilanthes coloratus Anders.

Undershrub in moist shady places; not common. Fls. Sept.-Oct. *Schizie* 474.

Amaranthaceae

Achyranthes aspera L. vern. 'Soh byrthied'.

Herb in partially shaded areas, associated with *Drymaria cordata;* rare. Fls. June-Oct. *Rao* 321 A.

Apiaceae (Umbelliferae)

Centella asiatica (L.) Urb.

(*Hydrocotyle asiatica* L.)

Prostrate herb rooting at nodes; common in marshy places. Fls. June-Oct. *Kharkongor* 828.

Araceae

Arisaema tortuosum (Wall.) Schott.

Tall herb among grasses in open places; rare. Fls. Sept. *Kharkongor* 548.

Asteraceae

Ageratum conyzoides L.

Herb with violet heads, common on grassy areas, associated with *Drymaria cordata* and *Mimosa pudica*; sparse. Fls. Major part of the year. *Kharkongor* 701.

* **Ainsliaea latifolia** (D. Don) Sch.-Bip.

(*A. pteropoda* DC.)

Slender herb common among grasses in open places. Fls. Nov. *Kharkongor* 762.

* **Anaphalis adnata** DC.

Fluffy herb common in grassy areas, associated with *Eupatorium* and the next species; common. Fls. Oct.-Nov. *Kharkongor* 531.

* **Anaphalis contorta** (D. Don) Hk. f.

Herbs commonly found in shady, gravelly soils, associated with *Desmodium* spp. and *Centella asiatica;* common. Fls. Sept.-Oct. *Kharkongor* 542.

* **Anaphalis griffithi** Hk. f.

Like the previous and often associated with it; common. Fls. Sept.-Nov. *Schizie* 2008.

Artemisia nilagirica (Cl.) Pamp.

(*A. vulgaris* auct. non L.)

Tall, aromatic herb growing at higher elevations and associated with *Eupatorium* sp. and *Bidens biternata;* very common. Fls. Oct. *Kharkongor* 570 A.

* **Bidens biternata** (Lour.) Merr. & Sherff.

(*B. pilosa* auct. non L.)

Tall erect herb common at higher elevations, often associated with *Artemisia nilagirica* and *Eupatorium adenophorum*; very common. Fls. Octo.-Nov. *Kharkongor* 388.

* **Chrysanthemum coronipifolium** Vill.

Tall slender herb very common in open grassy areas, probably an escape from cultivation. Fls. Sept.-Oct. *Kharkongor* 533.

* **Cosmos bipinnatus** Cav.

Tall, slender herb met with in open places, associated with grasses. An escape from cultivation. Fls. Oct.-Nov. *Kharkongor* 570.

Crossocephalum crepidioides (Benth.) S. Moore

Erect herb in open places having a preference for moist shady location; heads reddish; associated with grasses. Fls. Oct.-Nov. *Kharkongor* 591.

Emilia sonchifolia (L.) DC.

Slender herb on open sandy soils; leaves both radical and cauline; common. Fls. Sept.-Oct. *Kharkongor* 553.

* **Erigeron canadensis** L.

Erect herb common on margins of forests, among grasses. Fls. Sept.-Nov. *Kharkongor* 550.

* **Erigeron mucronatus** DC.

Decumbent herb, very variable in leaves and colour of heads; common among grasses and on walls, associated with *Drymaria cordata, Polygonum punctatum* and *Oxalis corniculata*; Fls. Feb.-Mar. *Kharkongor* 532.

* **Eupatorium adenophorum** Spreng.

(E. *glandulosum* H.B. & K.)

The commonest adventive weed found abundantly in all forests, associated with other *Eupatorium* spp.; heads white. Fls. March-April. *Kharkongor* 718.

Eupatorium riparium Regel.

Like the previous species and very commonly associated with it. Fls. Feb.-Mar. *Kharkongor* 716.

Eupatorium odoratum L.

Another adventive very common at lower elevations. Fls. Dec.-Feb. *Rao* 326.

Galinsoga parviflora Cav.

Erect glabrous herb; ray florets white; common in open places. Fls. Sept.-Nov.; April-Sept. *Kharkongor* 527.

* **Galinsoga ciliata** (Rafn.) Blake

Like the previous species and associated with it; differs in hairy nature of the plant; common Fls. Sept.-Nov. *Rao* 527 A.

* **Gerbera maxima** (D. Don) Beauv.

(*G. macrophylla* Benth.)

Herbs of shady places; associated with grasses and *Eupatorium*. Fls. Dec. *Kharkongor* 707.

Gnaphalium luteo-album L.

Woolly herb in marshy places among grass and *Centella asiatica,* occasional. Fls. Oct.-Feb. *Kharkongor* 715.

* **Hypochaeris radicata** L.

Slender herb with bright yellow heads; leaves basal only; common on open grassy soils. Fls. Sept.-Oct. *Kharkongor* 525.

Inula cappa DC.

Stout, woolly herbs to undershrub, common on open grassy soils. Fls. Oct.-Nov. *Kharkongor* 580.

Sonchus oleraceus L.

Herb with yellow heads; common outside the pine forests and near human habitations; Fls. Major part of the year. *Rao* 360.

Sonchus wightianus DC. subsp. **wightianus** Boulos

(*S. arvensis* L.)

Erect herb with glandular hairy stems and heads; common in open and shady places, associated with grasses. Fls. Mar.-July. *Rao* 361.

Tagetes patula L.

Probably an escape from cultivation; common on the outskirts of the pine forests in grassy areas. Fls. Oct.-Nov. *Kharkongor* 590.

* **Vernonia saligna** DC.

Undershrub, common in shade, associated with *Eupatorium adenophorum* and *Rubus micropetalus.* Fls. Nov.-Feb. *Schizie* 2018.

Xanthium strumarium L.

Hairy herb to undershrub, not common; Fls. Nov. *Rao* 177.

BALSAMINACEAE

* **Impatiens benthamii** V. Steen.

Slender herb in moist and shady places, associated with *Anaphalis* sp. Occasional. Fls. Aug.-Sept. *Schizie* 461.

* **Impatiens chinensis** L.
Glabrous slender herb in similar localities as the above; associated with *Eriocaulon* spp. and grasses, frequent. Fls. Aug. *Kharkongor* 503.

BETULACEAE

Alnus nepalensis D. Don
Large deciduous trees; occasional among pine trees. Fls. Oct.-Dec.

BORAGINACEAE

* **Cynoglossum lanceolatum** Forsk.
Tall, hispid herb in shady places, associated with grasses. Fls. Sept. *Kharkongor* 556.

BRASSICACEAE (Cruciferae)

Cardamine hirsuta L.
Suberect herb, glabrous; common in partially shaded areas, associated with *Polygonum punctatum*. Fls. Feb. *Kharkongor* 561, 714.

* **Nasturtium montanum** Wall.
Slender herb in shade, associated with *Centella asiatica* and *Hypochaeris radicata*; sparse. Fls. Oct. *Kharkongor* 577.

CAESALPINIACEAE

Cassia mimosoides L.
Diffuse herb on shaded grassy areas; flowers light yellow; sparse. Fls. Sept.-Oct. *Kharkongor* 540.

CARYOPHYLLACEAE

* **Drymaria cordata** Willd.
Slender herb common in marshy places, associated with *Galinsoga* spp. and grasses. Fls. Sept.-Nov. *Kharkongor* 522; *Thanchuma* 608.

COMMELINACEAE

Commelina paludosa Bl.
(*C. obliqua* Ham.)
Slender herb found in moist, grassy soils along the ravines; Fls. Sept. *Kharkongor* 538.

Cyanotis vaga (Lour.) Schult.
Slender glabrous herb in moist places, associated with grasses and sedges. Fls. Sept.-Oct. *Kharkongor* 507, 517.

CONVOLVULACEAE

Ipomoea nil (L.) Roth
(*I. hederaceae* auct. non Jacq.)
Climber on bushes and small trees; occasional. Fls. Oct.-Nov. *Kharkongor* 706.

CUSCUTACEAE

Cuscuta reflexa Roxb. vern. Jerini-uthri.
Leafless, twining parasite, common on *Duranta, Eupatorium* and *Cestrum*. Fls. Oct.-Nov. *Kharkongor* 592.

CYPERACEAE

Carex baccans Nees
Tall sedge on grassy areas, sparsely distributed in some pine forests. Fls. Sept.-Oct. *Kharkongor* 523.

Carex spiculata Boott.
Like the previous species and in similar localities; Fls. Aug.-Sept. *Myrthong* 1048.

Cyperus rotundus L.
Erect tufted herb, common in open places at the margin of forests. Fls. Aug.-Sept. *Kharkongor* 520.

Cyperus sesquiflorus Matt. f. et Kukanth
Erect tufted sedge in grassy places in shade. Fls. Sept.-Nov. *Kharkongor* 512.

Cyperus zollingeri Steud.
Common at lower elevations, like the previous species. Fls. Sept.-Oct. *Kharkongor* 510.

Fimbristylis tenera Schult.
Slender herb, common in open, moist areas, associated with grasses and other sedges. Fls. Aug.-Oct. *Myrthong* 1040.

ERIOCAULACEAE

Eriocaulon brownianum Mart.
Slender herb of marshy places; flowers in dense globose heads at the terminal ends of culms; associated with grasses and sedges and *Plantago* sp. Fls. Aug.-Sept. *Kharkongor* 501.

EUPHORBIACEAE

Phyllanthus urinaria L.
Erect herb in marshy areas; not common. Fls. Oct.-Nov. *Schizie* 487.

GENTIANACEAE

Gentiana quadrifida Bl.
Slender decumbent herb on open, grassy areas, associated with *Centella* and *Arthraxon*. Fls. Feb.-Mar. *Kharkongor* 712.

GERANIACEAE

* **Geranium nepalense** Sweet
Small herb in open grassy areas; common. Fls. Oct.-Nov. *Kharkongor* 600.

HYPERICACEAE

Hypericum napaulense Chois.
Herb of marshy places; occasional. Fls. Oct.-Nov. *Kharkongor* 493.

JUGLANDACEAE

Engelhardtia spicata Bl. vern. Dieng-lyba
Small tree; racemes pendent; fruits winged; common. Fls. May-Sept.

LAMIACEAE (Labiatae)

* **Ajuga macrosperma** Wall. ex Benth.
Short, decumbent herbs in shade; sparse. Fls. Oct.-Nov. *Kharkongor* 599.

Brunella vulgaris L.
Herb in shady places, associated with *Arundinella* spp; sparse. Fls. Aug.-Sept. *Schizie* 2006.

Clinopodium umbrosum (Bieb.) Koch
(*Calamintha umbrosa* Benth.)
Procumbent herb in grassland; sparse. Fls. Sept. *Kharkongor* 509.

Dysophylla auricularia (L.) Bl.
Coarse annual in open, moist places, associated with *Osbeckia crinita,* and *Cyanotis vaga,* sparse; Fls. Oct.-Dec. *Schizie* 494.

Elsholtzia pilosa Benth.
Erect hairy herb common among grasses; Fls. Sept.-Oct. *Kharkongor* 578, 704.

Leucas ciliata Benth.
Straggling, aromatic herb in shade; common. Fls. Sept.-Oct. *Schizie* 458.

Plectranthus coetsa Buch.-Ham.
Tall herb to undershrub in grasslands, sparse. Fls. Oct.-Nov. *Kharkongor* 574, 595.

Plectranthus striatus Benth.
(*P. hispidus* Benth.)
Herb to undershrub occasionally met with in shady places on slopes; Fls. Oct.-Nov. *Schizie* 463.

Scutellaria discolor Coleb.
Frequent, associated with the previous species. Fls. Sept.-Oct. *Kharkongor* 518.

LINACEAE

Disporum cantoniense (Lour.) Merr.
(*D. pullum* Salisb.)
Erect herb in shady places, associated with *Eupatorium* spp. Fls. Sept. *Schizie* 484.

LINACEAE

* **Reinwardtia indica** Dumont.
Stout herb with bright yellow flowers; rare. Fls. Sept.-Oct. *Kharkongor* 567.

LOBELIACEAE

* **Lobelia colorata** Wall.
Tall herb in marshes, associated with *Eriocaulon*, and sedges. Fls. Oct. *Thanchuma* 665.

* **Lobelia angulata** Forst.
Procumbent herb, associated with *Oxalis corniculata* and *Centella asiatica*. Fls. Sept.-Oct. *Kharkongor* 524, 563.

LYTHRACEAE

Rotala rotundifolia (Don) Koehne
Slender herb in marshes, associated with sedges and grasses; Fls. April *Kharkongor* 719.

MALVACEAE

Sida cordifolia L.
Herb in shady places; common at lower elevations, associated with *Eupatorium* and *Lantana*. Fls. Sept.-Oct. *Kharkongor* 516.

Urena lobata L. vern. Soh byrthit
Undershrub common at the outskirts of forests; leaves lobed, flowers pinkish; common. Fls. Sept.-Oct. *Kharkongor* 815.

MELLASTOMATACEAE

Osbeckia crinita Benth. vern. Dieng-Shokthem
Pubescent shrub, common on grassy slopes, associated with *Eupatorium* sp. Fls. Oct.-Nov. *Schizie* 462.

Osbeckia cristata
Occasional on slopes, in shady places; Fls. Oct.-Nov. *Kharkongor* 543.

* **Osbeckia glauca** Naud.
Slender herb in open places, associated with *Cyanotis vaga;* sparse. Fls. Oct.-Nov. *Kharkongor* 597.

* **Osbeckia nepalensis** Hk. f.
Undershrub to shrub in open places, associated with *Lantana* and *Eupatorium;* frequent. Fls. Sept.-Oct. *Schizie* 482.

MIMOSACEAE

* **Acacia mollissima** Willd.
Tree with yellow flowers in globose heads; not common; Fls. Feb.-Mar. *Kharkongor* 713.

Mimosa pudica L. vern. Kombatsamthia
Procumbent herb with sensitive leaflets; common in open places; Fls. Sept. *Schizie* 488.

MORACEAE

Ficus hirta Vahl: vern. Dieng-soh-rompain
Small tree in shady places, not common; Fls. Sept. *Schizie* 478.

Ficus hispida L. vern. Dieng-lapong
Small tree, occasional in lower elevations; Fls. Sept. *Schizie* 477.

MYRICACEAE

* **Myrica esculenta** Ham. ex D. Don: vern. Soh-phi
Small tree with tubercled fruits which are eaten.

ORCHIDACEAE

Anthogonium gracile Lindl.
Slender herb in open, moist places during monsoon. *Schizie* 495.

Cymbidium macrohizon Lindl.
Terrestrial orchids, in shaded, grassy places; rare. Fls. Nov. *Kharkongor* 596.

Herminium angustifolium (Lindl.) Benth. ex Hk. f.
Slender ground orchid common during monsoon, associated with *Imperata* and other grasses. Fls. Sept.-Oct. *Kharkongor* 555.

Zeuxine strateumatica (L.) Schl.
Ground orchid common during monsoon, in open places; Fls. Oct. *Kharkongor* 572.

OROBANCHACEAE

Aeginitia indica L.

Small, leafless parasite, in damp, shady places among the pine litter; associated with *Anaphalis adnata* and other species; frequent; Fls. Sept. *Kharkongor* 546.

OXALIDACEAE

* **Oxalis corniculata** L.

Small diffuse herb with stolon; flowers yellow and capsules bursting explosively when touched; common. Fls. Feb. *Kharkongor* 516.

PAPILIONACEAE

Clitoria mariana L.

Prostrate climber in partially shaded localities among grass; Fls. Sept.-Oct. *Schizie* 466.

* **Crotalaria albida** Roth

Tall slender herb in shade, associated with *Eupatorium* and *Bidens;* flowers yellow. Fls. Nov.-Dec. *Schizie* 2016.

Crotalaria ferruginea Grah. ex Benth.

Herb in grassy places, not common; Fls. Oct.-Nov. *Schizie* 2004.

Crotalaria occulta Grah. ex Benth.

Suffruticose herb in shade at the margin of pine forests; Fls. Sept. *Kharkongor* 547.

Desmodium concinnum DC.

Common undergrowth in pine forest at lower elevations; Fls. Oct. *Kharkongor* 544.

Desmodium heterophyllum (Willd.) DC.

Occasional in open places; Fls. Oct.-Nov. *Schizie* 454.

Desmodium microphyllum (Thunb.) DC.

Prostrate, diffuse herb in moist places; associated with grasses; common. Fls. Sept. *Kharkongor* 505.

Desmodium heterocarpum (L.) DC.
(*D. polycarpum* DC.)

Suffrutescent plants, frequently seen associated with other *Desmodium* sp. Fls. July-Sept. *Kharkongor* 579.

Desmodium pseudotriquetrum (DC.) Prain

Slender, woody plant in shady places; associated with *Lantana camara.* Fls. Aug.-Oct. *Schizie* 480.

Desmodium racemosum (Thunb.) DC. vern. Ja-top-rit

Decumbent plants in open and shady places; Fls. Aug.-Sept. *Schizie* 479.

Desmodium sinuatum Bl.

Occasional on grassy slopes; Fls. Sept.-Oct. *Kharkongor* 569.

* **Erythrina indica** Lamk.

Tree with bright red flowers; occasional at lower elevations at the margin of pine forests. Fls. March-April.

Parochetus communis Buch.-Ham. ex Don

Slender diffuse herb in moist places among mosses; associated with *Oxalis* sp. and *Drymaria cordata;* Fls. Sept.-Oct. *Kharkongor* 568.

Pueraria lobata Willd. vern. Suting-rit

Twiner on small bushes; occasional; Fls. Sept.-Oct. *Schizie* 489.

Smithia blanda Wall. vern. Bat-shakuriao

Erect herb of marshes, associated with grasses and sedges; Fls. Aug. *Thanchuma* 602.

Smithia ciliata Royle

Like the previous species and often found in similar localities. *Kharkongor* 571.

Tephrosia tinctoria Pers.

Undershrub in partially shaded areas; common in lower elevations; Fls. Sept.-Oct. *Kharkongor* 519.

Trifolium repens L.

Small trailing herb in shady places; occasional. Fls. Feb.-Mar. *Kharkongor* 708.

PLANTAGINACEAE

Plantago major L.

Herb of moist places; frequent along the

ravines, associated with grasses. Fls. Sept.-Oct. *Kharkongor* 564.

Poaceae (Graminae)

Arthraxon quartinianus (Rich.) Nash.

Common. Fls. Oct.-Nov. *Kharkongor* 594.

Arundinella bengalensis (Spreng.) Druce

Tall grass with brown spikelets, associated with *Bidens* and *Eupatorium*. Fls. Sept.-Oct. *Kharkongor* 511.

Arundinella nepalensis Trin.

Common in shade; Fls. July-Sept. *Kharkongor* 376.

Axonopus compressus (Sw.) Beauv.

Slender grass, associated with *Oxalis* sp. and other grasses. Fls. Sept. *Kharkongor* 366.

Bothriochloa pertusa (Willd.) A. Camus

Tufted grass with brownish culms; occasional. Fls. Sept.-Nov. *Kharkongor* 560.

Brachiaria villosa A. Camus

Frequent at the margin of forests; Fls. Sept.-Oct. *Kharkongor* 396.

Capillipedium assimile (Steud.) A. Camus

Tall slender grass, associated with *Eupatorium adenophorum* and *Artemisia nilagirica*. *Kharkongor* 552.

Chrysopogon aciculatus (Retz.) Trin.

Tufted grass, common in open places, associated with *Centella* and other grasses; Fls. Sept.-Oct. *Kharkongor* 390.

Cymbopogon khasianus (Hack.) Stapf ex Bor

Tall grass with greenish red spikelets, associated with *Eupatorium* spp. common inside the forests; Fls. Nov. *Kharkongor* 705.

Eleusine indica (L.) Gaertn.

Common in marshy places during monsoon. *Kharkongor* 549.

Eragrostis nigra Nees ex Steud.

Slender grass with dark-green spikelets, associated with *Eupatorium*, common in shade; Fls. Sept.-Nov. *Kharkongor* 530.

Eragrostis unioloides (Retz.) Nees ex Steud.

Like the previous species, but not so common; Fls. Nov. *Neogi* 2573.

Eulalia fastigata (Nees) Haines

Tall grass with brownish spikelets, associated with other grasses; common on loose soils; Fls. Nov. *Kharkongor* 703.

Imperata cylindrica (L.) Beauv.

Tall slender grass in open places; spikes white when mature; not common; Fls. Oct.-Nov. *Kharkongor* 387.

Isachne clarkei Hk. f.

Tall grass in shade and among *Lantana* bushes; occasional. Fls. Sept. *Kharkongor* 521.

Microstegium ciliatum (Trin.) A. Camus.

Common in open places; Fls. Oct.-Nov. *Kharkongor* 377.

Oplismenus burmanii (Retz.) Beauv.

Very common in moist shady places, specially in loose soils, associated with *Drymaria cordata,* and *Oxalis corniculata*. Fls. Sept.-Oct. *Kharkongor* 529.

Oplismenus compositus (L.) Beauv.

In similar localities as the above, but more common in lower elevations. *Myrthong* 1183.

Oryza meyeriana Baill.

Tall grass in shade, associated with *Eupatorium,* and *Lantana*. *Kharkongor* 373.

Panicum brevifolium Roxb.

Common in open places. Fls. Sept.-Oct. *Kharkongor* 515.

Paspalum dilatatum Poir.

Tall grass in open places, associated with other grasses and *Eupatorium* sp., occasional; Fls. Sept.-Nov. *Kharkongor* 513.

Pennisetum typhoides Stapf ex Hubb.

Procumbent herbs, associated with *Eupatorium* spp.; frequent. *Myrthong* 1124.

Poa annua L.

Small, tufted grass, very common in open

places, associated with other grasses; Fls. July-Sept. *Kharkongor* 364.

Sacciolepis indica (L.) Chase

Common in marshes; Fls. July-Sept. *Myrthong* 1405.

Setaria glauca (L.) Beauv.

Tufted grasses, occasional in lower elevations, associated with *Plantago* and *Drymaria;* Fls. Sept.-Nov. *Kharkongor* 566.

Setaria palmifolia (Koen.) Stapf

Common in open places, associated with *Eupatorium;* leaves palm-like with prominent veins. Fls. Sept.-Nov. *Kharkongor* 528.

Sporobolus fertilis (Steud.) Clayton

(*S. indicus* auct. non L.) R. Br.

Common in open places, associated with other grasses. Fls. Sept.-Nov. *Kharkongor* 551.

Themeda villosa Dur. et Jack.

Stout grass in moist shady places, associated with *Osbeckia* sp. and *Lantana;* not common. Fls. Sept.-Oct. *Schizie* 481.

Polygalaceae

* **Polygala persicariaefolia** DC.

Herb, common in shady places at lower elevations. Fls. Sept.-Oct. *Schizie* 481.

Polygonaceae

Fagopyrum dibotrys (D. Don) Hara

Tall puberulous herb, common in moist places; Fls. Sept.-Nov. *Kharkongor* 537.

Polygonum hydropiper L.

Tall herb, lower nodes rooting; common in marshes along the ravines. Fls. July-Oct. *Neogi* 2284.

Polygonum punctatum L.

(*P. alatum* Buch.-Ham. ex Spreng.)

Slender herb with globose heads; common in marshes and in open places; Fls. Sept.-Nov. *Kharkongor* 526.

Ranunculaceae

* **Delphinium denudatum** Wall. ex Hk. f. & Th.

Herb with purplish-blue flowers; rare. Fls. Nov. *Kharkongor* 599.

Ranunculus diffusus DC.

Small diffuse herb in marshes, associated with *Drymaria cordata* and grasses; sparse. Fls. July-Sept. *Kharkongor* 541.

Rosaceae

Agrimonia eupatorium L. vern. Lynniang-lynning

Herb in shady places; sparse. Fls. Dec. *Schizie* 468.

Duchesnea indica (Ander.) Focke

(*Fragaria indica* Ander.)

Small procumbent herb with bright red fruits; Fls. & Frts. Sept. *Kharkongor* 504.

Neillia thyrsiflora D. Don vern. Torsuin

Shrub, branches drooping; occasional in shady places; Frts. Oct. *Kharkongor* 585.

Potentilla fulgens Wall. ex Lehm. vern. Lyngiang-bru

Herb with stout rootstocks, common in partially shaded places in grassland; Fls. Sept. *Kharkongor* 565.

* **Potentilla mooniana** Wt.

(*P. polyphylla* Wall.)

Decumbent herb in shade, associated with *Cyanotis vaga* and *Eupatorium* spp., sparse; Fls. Aug.-Sept. *Schizie* 464.

Rubus ellipticus Sm. vern. Sia-soh-bru

Prickly, straggling shrubs; occasional in the shrubby stratum in pine forests; Fls. Feb.-March; *Kharkongor* 709.

Rubus micropetalus Gardner

Shrub with straggling prickly branches; common in shade; Fls. & Frts. Aug.-Nov. *Kharkongor* 393.

RUBIACEAE

Borreria articularis (L.f.) Will.
(*B. hispida* Schum.)
Procumbent herb, branches quadrangular; flowers white; very abundant in some pine forest, at lower elevation; Fls. July-Sept.

* **Borreria ocymoides** (Burm. f.) DC.
Like the previous species, but not so common; Fls. July-Sept. *Kharkongor* 554.

Galium elegans Wall.
(*G. rotundifolium* Hk. f.)
Hairy herb, branches climbing or straggling; very common among *Eupatorium* bushes; Fls. July-Sept. *Kharkongor* 506.

* **Oldenlandia corymbosa** L.
Slender herb in marshy places; not common; Fls. Sept. *Kharkongor* 539.

Rubia cordifolia L. vern. Soh-misem
Scabrid climbing herb; common on *Lantana* and *Eupatorium* in Pine forests. *Kharkongor* 506A.

SCROPHULARIACEAE

* **Lindernia anagallis** (Burm. f.) Penn.
(*L. cordifolia* Merr.)
Decumbent herb of marshy places, along the ravines, associated with grasses and sedges and *Drymaria cordata;* Fls. Sept., *Kharkongor* 514.

SOLANACEAE

Brugmansia suaveolens (Willd.) Bercht. & Presl.
Shrubs with large white, pendent flowers; common all along the ravines and streams; Fls. Major part of the year; *Mahanta* 404.

Cestrum aurantiacum Lindl.
Probably an escape from cultivation; flowers orange coloured. Fls. Oct. *Kharkongor* 568.

Nicandra physalodes (L.) Gaertn.
Large herb with blue flowers; common in waste places; Fls. July-Nov. *Schizie* 460.

Solanum myriacanthum Dun.
(*S. khasianum* Cl.)
Prickly shrub with bright yellow, globose berries, frequent in open places; Fls. Aug.-Sept. *Mahanta* 413.

Solanum sisymbrifolium Lamk.
Very prickly shrub; flowers bluish; berries red when ripe; not common in pine forests; Fls. July-Sept. *Mahanta* 414.

Solanum torvum Sw. vern. Dieng-soh-nonag
Pubescent shrub with white flowers, and globose berries; not common. Fls. June-Sept. *Mahanta* 404.

SMILACACEAE

Smilax sp.
Climbing on other bushes; not observed in flowers.

SYMPLOCACEAE

Symplocos racemosa Roxb.
Small tree with globose, scarlet fruits; frequent; Fls. June-Oct.

THEACEAE

Eurya japonica Thunb.
Shrub associated with *Eupatorium* spp.

TERNSTROEMIACEAE

Schima khasiana Dyer.
Tree, occasionally found associated with pine trees; Fls. June-Aug.

TILIACEAE

Triumfetta pilosa Roth.
Hispid undershrub to shrub, flowers pinkish; *Schizie* 2015.

Urticaceae

Pouzolzia hirta Hassk. vern. Jamynsleh
Common in marshy places; *Schizie* 486.

Valerianaceae

Valeriana hardwickii Wall.
Common undergrowth in pine forests, flowers white; Fls. Sept.-Nov. *Kharkongor* 545.

Verbenaceae

Clerodendrum serratum (L.) Moon vern. Rilong-phlang
Undershrub to shrub, flowers white; frequent. *Kharkongor* 586.

Duranta plumieri Jacq.
Shrub, commonly found in hedges near pine forests; rarely found inside the forests; flowers blue; fruits orange when ripe; *Rao* 309.

Lantana camara L. var. **aculeata** (L.) Moldenke vern. Soh-pang khlieh
Straggling, prickly shrub, very common and abundant in some places. Fls. major part of the year; *Kharkongor* 535.

Violaceae

Viola serpens Wall. ex Benth.
Slender herb in shady places; not common; Fls. Feb.-Mar. *Kharkongor* 491.

Zingiberaceae

Costus speciosus (Koenig.) Sm.
Tall, stout herb with red, cone-like spikes; occasionally found in shaded areas; Fls. Nov. *Schizie* 475.

Hedychium gardnerianum Rosc.
Tall herb in marshy places; flowers white, fragrant; common. Fls. Sept. *Schizie* 476.

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OCCURRENCE OF THE HERMIT CRAB *DARDANUS SETIFER* (H. MILNE-EDWARDS) (DECAPODA, ANOMURA) AT KARWAR WITH A DESCRIPTION OF THE FIRST ZOEAL STAGE[1]

V. N. NAYAK[2] AND V. S. KAKATI[3]

(*With two text-figures*)

Dardanus setifer (H. Milne-Edwards) originally described as *Pagurus setifer* is a widely distributed hermit crab of the genus *Dardanus* recorded from various parts of the Indo-Pacific region from 2-50 fathoms (Henderson 1893; Alcock 1905; Southwell 1906; Sundara Raj 1927; and Barnard 1950). However, so far no record has been made of the genus from the northern part of the west coast of India.

A berried female was collected on 14.iv.1976 from the intertidal rocky shore at Binga, about 7 km from Karwar. The crab was kept alive in an aquarium until the eggs hatched on 22.iv.1976. After hatching of the eggs, the adult was preserved and dissected for taxonomic studies.

Dardanus setifer (H. Milne-Edwards)
(Fig. 1)

Pagurus setifer: Milne-Edwards, 1836, p. 274; Milne-Edwards, 1837, p. 225; De Haan, 1849, p. 209; Muller, 1886, p. 472; Henderson, 1893, p. 420; Alcock, 1905, p. 83; Southwell, 1906, p. 214; Lenz, 1910, p. 563; Terao, 1913, p. 379; Balss, 1921a, p. 19; Sundara Raj, 1927, p. 131; Barnard, 1950, p. 426.

Pagurus scultipes: Stimpson, 1859, p. 246; Ortmann, 1892, p. 287; Ortmann, 1897, p. 275; Doflein, 1902, p. 646; Rathbun, 1903, p. 34; Stimpson, 1907, p. 205; Lenz, 1910, p. 563; Balss, 1913, p. 48; Parisi, 1918, p. 112.

Pagurus pavimentatus: Hilgendorf, 1878, p. 816; Whitelegge, 1889.

Eupagurus setifer: Haswell, 1882, p. 154.

Distribution: INDIA—Malabar coast, Gulf of Mannar, Madras; Sri Lanka; East Africa; Mauritius; East Indies; Hongkong.

Diagnosis (Fig. 1, a & b): Shield almost as long as broad; eye-stalks elongated, cylindrical, equal in length to the distal border of carapace, and as long as antennular peduncle. Antennal flagellum nearly $2\frac{1}{2}$ times longer than the shield, with inner-distal joints produced in the anterior half. Upper surface of chelipeds and of 2nd and 3rd legs densely covered with bristles, and black-tipped, thorn-like tubercles; the bristles being fine and short and fail to hide the tubercles and surface sculpture. On the propodus of the left cheliped (large) the bristles form wreathes around the bases of the tubercles, and along the lower margin the spines are grouped in palisade fashion (best seen from the outside). The dactylus and propodus of 3rd left leg (Fig. 1, b) broadened (breadth of propodus nearly 3/5th the length) with a sort of toothed or crenulated edges, outer surface flattened and concave, with a longitudinal ridge or keel, the surface with pavement-like sculpture of regular transverse,

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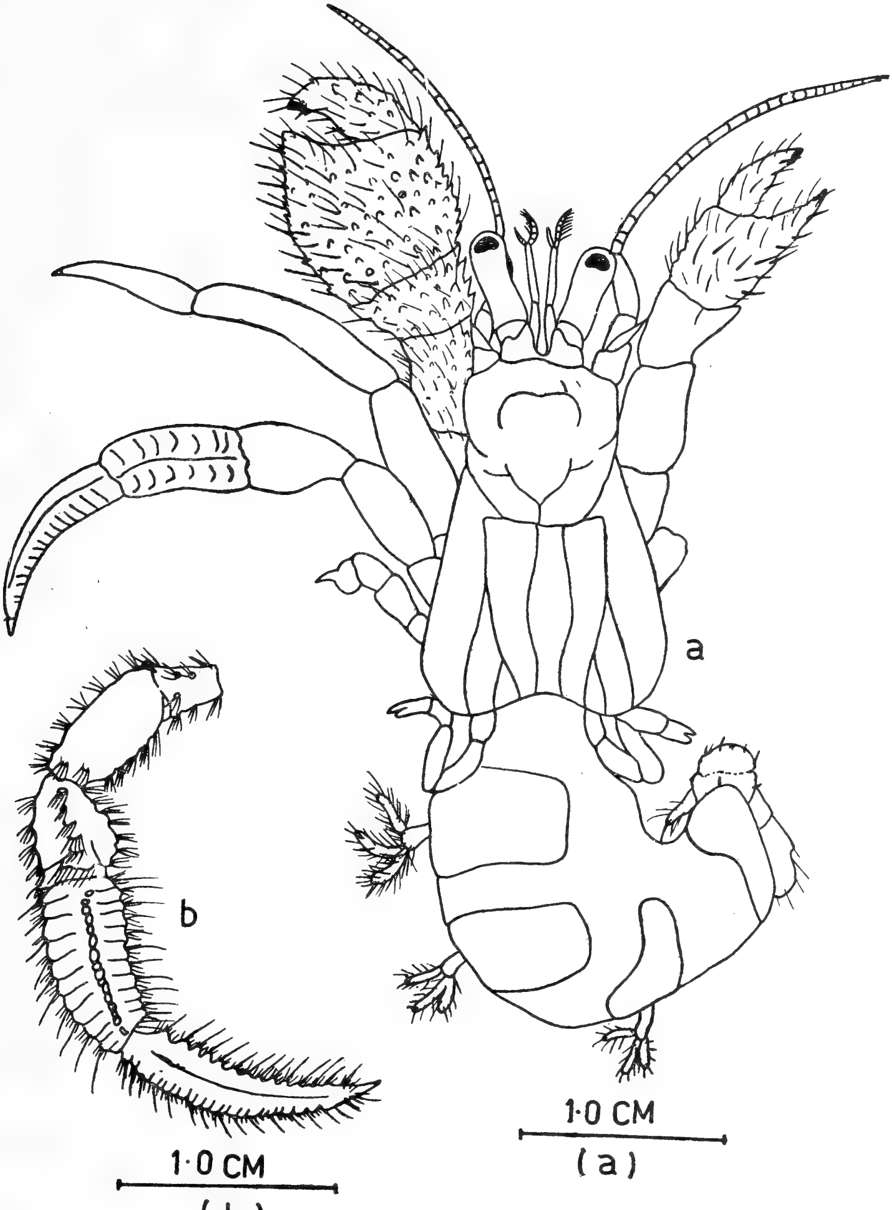

Fig. 1. *Dardanus setifer* (H. Milne-Edwards), adult female: a. entire animal (dorsal view); b. third pereiopod (left).

deep-cut grooves or tessellations. This form and sculpture of the 3rd left leg is characteristic.

Eggs oval, orange red (when immature) changing to pale and semi transparent (when about to hatch); egg size 0.22 to 0.26 mm x 0.25 to 0.28 mm.

Colour: The general body colour is reddish brown with scattered white spots all over the body. Antennule, antenna and maxillipeds light yellow. Palm of the large cheliped dark brown. Joints of pereiopods pale blue.

Ecology: The specimen was collected from the exposed rocky bed of intertidal zone during low tide, on the seaward side of a rock. The rock was encrustated with green and brown algae and shells of *Babylonium* occupied by hermit crabs.

Material examined: Binga bay, 1 berried female, in the shell of *Babylonium* sp.; date of collection—14.iv.1976; shield length—9 mm.

Remarks: The present collection is a northward extension of its range on the west coast.

First zoea
(Fig. 2)

Rostrum length: 0.37 mm; Carapace length: 0.99 mm; Abdomen length: 1.10 mm.

Rostrum extends well beyond the antennule and antennal scale, sides almost parallel up to nearly 2/3rd of the distance and then tapering to a sharp point; presence of a short carina at the base of the rostrum; posterior carapace smooth and postero-lateral angle rounded; abdomen smooth except for a pair of curved lateral spines situated subterminally on the 5th segment; absence of terminal spine on the antennal scale.

No distinct chromatophores, but the rostrum and abdominal regions light orange; mouth parts pale like the remaining parts of the body; diffused light yellow chromatophores around the eye.

Antennule (Fig. 2, b): extends nearly to 1/2 of the rostrum and bears 3 aesthetascs and 3 unequal setae terminally and a single large plumose seta sub-terminally on a papilla representing the inner ramus. *Antenna* (Fig. 2, c): Endopod more than half as long as the scale and terminally bears 2 long subequal setae and a short outer one about 1/7th as long; scale bears 10 setae on its inner margin, the outermost being the smallest; outer margin of the scale with fine hairs; Basipod with a stout spine, serrated on the inner margin, distally. *Mandibles* (Fig. 2, d): Asymmetrical and with numerous strong teeth; no palp. *First maxilla* (Fig. 2, e): Coxal endite with 5 + 2 setae; basal with 2 stout serrated teeth-like and 2 small setae; endopod unsegmented and elongated with 2 unequal setae terminally. *Second maxilla* (Fig. 2, f): Scaphognathite with 5 plumose, marginal setae; endopod bears 2 + 2 setae terminally; basal endite with 4 + 5 and coxal with 4 + 6 setae as illustrated. *First maxilliped* (Fig. 2, g): The unsegmented exopod bears 4 natatory setae terminally; the setation on the 5-segmented endopod being 3, 2, 1, 2 and 4 + 1 respectively from 1st to 5th segments; inner margin of 2nd and 3rd segments bear fine hairs; the latero-proximal corner of the basipod is terminated in a blunt curved lobe with a tiny spine-like seta; basipod bears 8 setae. *Second maxilliped* (Fig. 2, h): Exopod as in first maxilliped; endopod 4-segmented with setation 2, 2, 2 and 4 + 1 distalwards; basipod with 3 setae and the latero-proximal angle smooth. *Third maxilliped* (Fig. 2, i): Small uniramous bud. *Pereiopods*: Not yet developed. *Telson* (Fig. 2, r): Maximum width of the telson is slightly greater than the combined length of the telson and the 6th abdominal somite, to which it is fused; presence of a

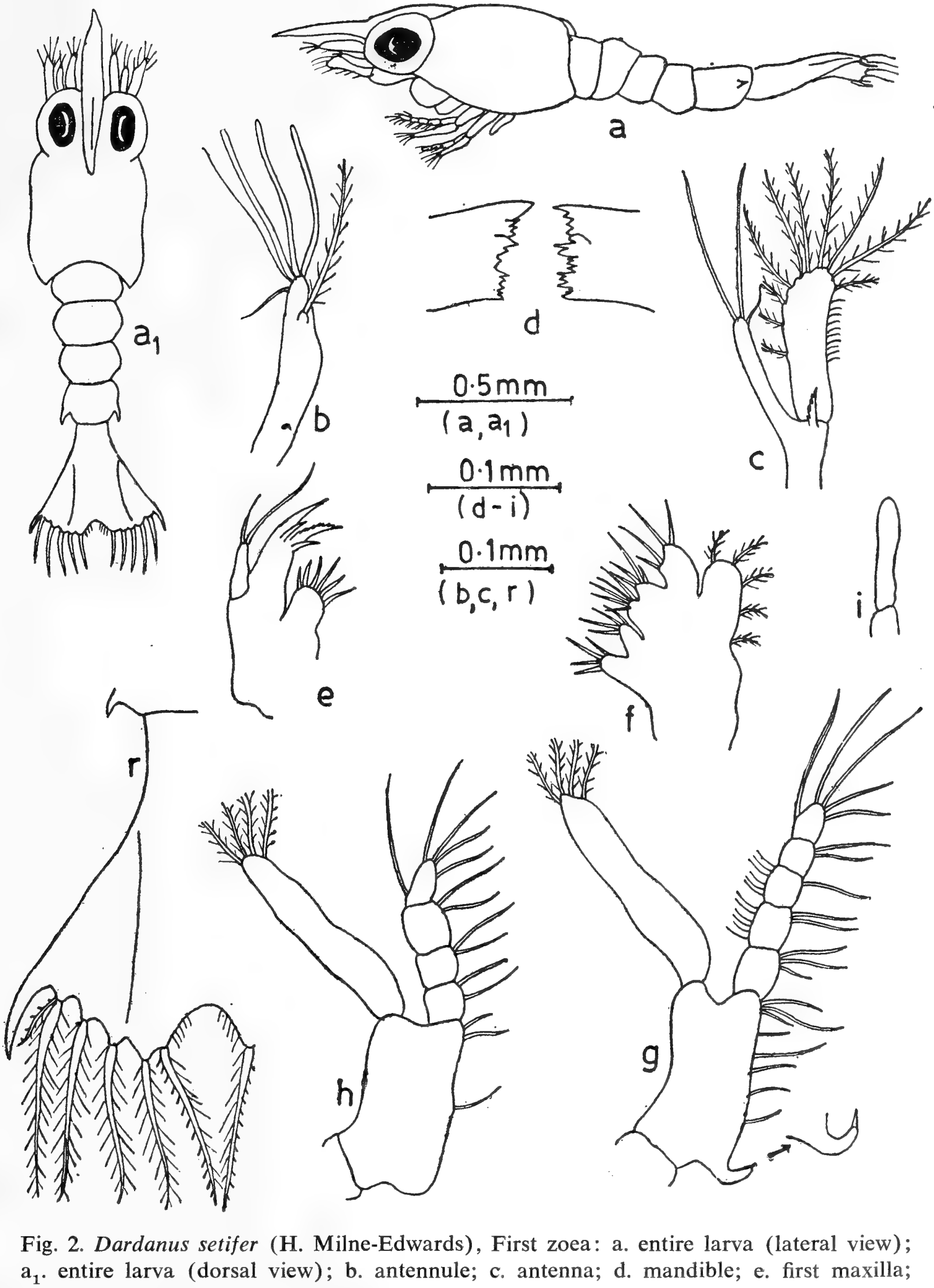

Fig. 2. *Dardanus setifer* (H. Milne-Edwards), First zoea: a. entire larva (lateral view); a_1. entire larva (dorsal view); b. antennule; c. antenna; d. mandible; e. first maxilla; f. second maxilla; g. first maxilliped; h. second maxilliped; i. third maxilliped; r. telson.

longitudinal ridge on either side of the telson; process formula 7 + 7; 1st, rather long, unarticulated and incurved spine, next a typical 'anomuran hair'; 3rd to 7th, plumose setae, 3rd being the longest; 7th with spinules on the outer margin; telson notch and posterior border with fine hairs.

Discussion

First stage zoea of *Dardanus arrosor* has been described by Issel (1910), Boraschi (1921), Pike and Williamson (1960), Bourdillon—Casanova (1960), DeChance (1962) and Kurata (1968). DeChance obtained larvae of 3 species of *Dardanus* from plankton duly comparing with *D. arrosor*. But this identification is only upto the genus level. Moreover, the complete larval development in the laboratory is known only in one species, *D. arrosor*, as described by Kurata (1968). Therefore, in the present discussion only *D. arrosor* has been considered for comparison.

The first stage zoea of *D. setifer* differs from that of *D. arrosor* mainly in the following: 1. The surface of cuticle has a scaly appearance in *D. arrosor* (Pike & Williamson and DeChance) whereas no such scales are seen in the present material. 2. Size: Pike and Williamson give the length of the 1st stage larva of *D. arrosor* as 3.1 mm whereas in the present material it is only 2.09 mm; carapace length in *D. arrosor* is 1.6 mm while in the present material 0.99 mm. 3. Antennule: Pike and Williamson show single aesthetasc and a seta in the former whereas in our material there are 3 aesthetascs and 3 setae in addition to a long plumose seta common to both species. 4. According to DeChance the palp of the 1st maxilla in *D. arrosor* bears 3 setae whereas Pike and Williamson observe only two setae. In the present material the unsegmented palp consists of 2 setae only.

The following characters may be considered as important generic features of first zoea.

1. Presence of a lobe at the latero-proximal angle of the basipod of 1st maxilliped (Fig. 2, g).
2. Presence of a longitudinal ridge on either side of mid-dorsal line of telson (Fig. 2, r).

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PHEASANT SURVEYS IN PAKISTAN[1]

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All the five species of Pheasants of Pakistan are getting rare year by year mainly because of poaching and destruction of their habitat. Their range of occurrence is shrinking. Some of these have become so rare that they are considered threatened with extinction and are registered in IUCN Red Data Book. These are:

1. Western Horned Tragopan *Tragopan melanocephalus* once occurred in Indus Kohistan, District Swat, in Hazara Kohistan and Kaghan Valley, District Hazara and in Azad Kashmir mainly in Neelam Valley.

2. Cheer Pheasant *Catreus wallichii* was once common in foot hills of NWFP, Punjab and Azad Kashmir.

The other three species are Monal *Lophophorus impejanus* which occurred in Safed Koh mountains of NWFP, in Swat, Gilgit, District Hazara including Gallies and Azad Kashmir. White Crested Kalij *Lophura leucomelana* in Swat, District Hazara in Kaghan Valley and Gallies, District Rawalpindi in Murree foot hills and Margala hills and in Azad Kashmir and the Koklas *Pucrasia macrolopha* found on forested slopes of mountains of Chitral, Dir, Swat, Hazara, Rawalpindi and Azad Kashmir.

Very little information is available regarding the status of these species. There is no basis to designate the status of any of these species except some published accounts (Roberts 1970, Mirza 1971, Wayre 1971 and Khan 1976).

In May and August, 1977 WWFP/WPA[5] organized the first systematic survey of habitat and population of Pheasants.

HABITAT DESCRIPTION

Neelam Valley: Kuttan forest, Salkhala Game Reserve and Machyara Game Reserve are most suitable habitats for Koklas, Monal and Western Horned Tragopan. The elevation varies between 1500 to 4500 metres. These are thickly forested, with sparse to thick undergrowth. The forests are in a transition zone between moist temperate and dry temperate and show the mixed characteristics. Koklas and Monal Pheasants were observed to prefer dense forests with plenty of undergrowth, where they could roost at night on the trees and find shelter in the undergrowth during day time. Monal were also seen inhabiting alpine zone just above the tree line or in some areas where birch trees grow.

Tragopan were found occupying steep hill slopes with some vegetation where there were not much chances of disturbance of any sort. However, in August these were seen also on gentle slopes with thick vegetation.

Hazara: Parts of Kaghan Valley (Shogran, Malakandi, Manshi and Gallies), Dunga Gali Pipe Line Forests, Retli, Darwaza Forest, were also visited. The areas are suitable for Koklas. The forests are moist temperate type.

The main tree species in Kaghan (the parts visited) is blue pine (*Pinus wallichiana*) occurring equally mixed with deodar *Cedrus deodara* in Shogran and Malakandi forest. In Gallies forests, fir (*Abies pindrow*) and spruce

[1] Accepted October 1977.

[2],[4] World Wildlife Fund Pakistan, P.O. Box 1312, Lahore, Pakistan.

[3] Pakistan Forest Institute, Peshwar, Pakistan.

[5] World Wildlife Fund Pakistan/World Pheasant Association Pakistan.

(*Picea smithiana*) are the predominant species, whereas blue pine forms a major part of the mixture on elevations lower than 2500 m. *Quercus dilatata* and *Quercus semicarpifolia* are found here.

The forests are moist temperate. Deodar (only in Malakandi forests) and blue pine are the dominant species whereas fir and spruce are mixed along with it in smaller proportions.

Thick bushy cover provided shelter for the Pheasants and trees over them for roosting.

Gallies: The forests are moist temperate. Fir and spruce are the dominant species on higher elevations whereas blue pine is associated as a co-dominant (dominant on lower elevations).

Lower elevations is Gallies forests are the habitat for Kalij Pheasant. Thick shrubby growth of *Myrsine africana, Rosa macrophylla, R. moschata* and *Berberis lycium* offers maximum protection to the bird.

Surveys

Koklas Census:

The census of this Pheasant was carried out from 4th to 23rd May, 1977 in some areas of Kaghan Valley, Gallies and Neelam Valley and again from 13th August to 23rd August, 1977 in Neelam Valley. The bird occurs at elevations between 1600-2800 m. In May and August it was recorded as high as 2900 m. It prefers moist temperate coniferous forests with shrubby undergrowth, spending the whole day feeding and hiding in the shrubs and roosting on trees at night. In May these birds start calling in the morning, just before dawn, 20 to 30 minutes before alighting from trees and then for about another one hour they keep calling from ground. The first call was heard at 4.30 a.m. in May. However, in August the first call was recorded at 5.00 a.m. The intensity of calls was comparatively less. The population was estimated by listening to the morning calls only for 20 minutes after the first call because when the birds alight from trees they change their positions and the new calls are most likely to be confused as coming from new birds. The position of each member of the team for listening to the calls was predetermined during the reconnaissance survey which was done one day before for each area. Elevation of each person's position was also recorded by altimeters during the preliminary surveys. This enabled each person to estimate approximate elevation of each calling bird. Each person also made a sketch map of the area where he was listening to the calls and plotted the approximate position of each calling bird on the sketch map. After listening to the calls the members of the team with adjacent positions compared the marked positions of the calling birds on their sketch maps and eliminated the common counts.

In Kaghan Valley 200 calling birds were counted in 16½ sq. mile areas; Shogran 105 birds in 9 sq. mile area; Malakandi 33 birds in 4½ sq. mile area and Manshi 62 birds in 3 sq. mile area.

Similarly in Gallies 88 calling birds were counted in 6½ sq. mile area; Retli, Dungagali Pipeline Forest and Darwaza forest.

In Neelam Valley there were 100 calling birds in 22 sq. mile area in May 1977; Salkhala 60 birds in 12 sq. mile area and in Kuttan 40 birds in 10 sq. mile area. In this area the teams were concentrating more on Tragopan count and Koklas count was not as thorough as in other areas. The calls were estimated from higher elevation comparative to the range of occurrence of Koklas Pheasant at that time of the year. In August the counting was exclusively for Koklas in Machyara area where 538 calling birds were counted in 20 sq. mile area.

Monal Estimate:

In May 1977 some Monals were heard calling in the morning and some were flushed with the help of a dog at elevation 2450 - 3200 m. in Kuttan and Salkhala areas. Only 41 Monals could be listened or flushed in 16 sq. mile area. The calls of the Monal is less audible from distance as compared to Koklas Pheasant. Since the terrain in which it occurs is very difficult, therefore, call method estimate of population was found to be impossible by the members of the team. Although attempts were made but much of the area remained uncovered. Only 10 calling birds were heard in Salkhala and 15 calling birds were heard in Kuttan.

Attempts were made to flush the birds with the help of a dog but that method was also impossible for several areas. In order to get some idea of the population of this bird this method was adopted on some comparatively easy slopes. 8 males and 5 females were flushed in Salkhala and 7 males and 3 females were flushed in Kuttan area. In August 1977 in Machyara Game Reserve area estimate of Monal population was made by listening to the calls of the males, by beating some areas with the help of beaters and also by chance sighting of some birds in the range of their occurrence which was at that time of the year between 2875 to 3800 m high. The topographical features of this area are more gentle slopes, some plateaus, few steep hills and very few precipitous cliffs, therefore, it was possible for some members of the team to get better idea of these birds. 50 calling birds were recorded, 6 males and 2 females were flushed and 2 males and one female were just sighted on steep floor of the forest in a 13 sq. mile area. It was observed that Monal also occur on very gentle slopes. Their main concentration, however, was on steep and precipitous cliffs. We now believe that steep and precipitous hill slopes are not the particular habitat criteria of this Pheasant. Occurrence in such area is perhaps their adaptation for survival from their enemies, of which the man is the worst. To further endorse our view we refer to Roberts (1970) who recorded "in early 1950s in gallies the Monal was regularly seen and shot in Mukshpuri hills, but according to the local people it had not been seen there for the last 8 or 9 years". Mukshpuri hills 2875 m has gentle slopes all around and the eradication of Monal from this area is due to man's action.

Western Horned Tragopan Count:

Philip Wayre 1971 could only get indirect evidence of occurrence of this Pheasant in Kaghan Valley. During our census of Koklas no evidence of its occurrence in Kaghan Valley could be obtained. Although two years ago a male Tragopan was obtained by NWFP Wildlife Department for captive breeding of this species. This specimen was reportedly collected from Bichela Valley. This valley is adjacent to sub valley in Azad Kashmir where the bird is still thriving. It is also likely that this bird was actually trapped from across the border in Azad Kashmir. Robert 1970 reports the obtaining of a skin allegedly killed in Murree hills. He states "occasional birds wander in winter in the Murree hills and are shot there". But on the basis of present position of this bird in Azad Kashmir, it appears unlikely.

Tragopan is still common in Azad Kashmir in some pockets. In May 1977 its counting was attempted by call method as well as by flush method in Salkhala and Kuttan Game Reserves and again in August 1977 in Machyara, Neelam Valley, Azad Kashmir.

In Salkhala mainly around Charehan 12 calling males were recorded at an elevation 3000 to 3175 m. With the help of beaters 2 males

and 4 females were flushed. All these 18 birds were recorded in 12 sq. mile area. In Kuttan Game Reserve 9 birds were recorded by call method and 7 males and 4 females were flushed with the help of a dog in 10 sq. mile area. Due to the very difficult terrain it was impossible to survey the area thoroughly and totally. Therefore, we believe the population of this bird in these areas is much more higher than the figures given by us. Another reason for this indication of higher population is that in the month of May the breeding season had commenced and as we feel the females have the tendency to remain inconspicuously hidden in sheltered places, whereas the males usually easily flush out, probably to divert the attention of the intruders.

In Machyara, in August 1977, a total of 7 males and 6 females were sighted by beat method. Out of these 1 male in full plumage, 2 young males and 3 females were sighted together on almost horizontal slope of a hill covered with thick *Quercus* forest at an elevation 2825 m. In the total area of 20 sq. miles all these birds were found in one patch of 3 sq. miles *Quercus* forest. In Machyara our census was more thorough because of comparatively easy terrain. Tragopan has the tendency to live in undisturbed areas even if it is a plateau. However, apparently because of great disturbance due to heavy human population this bird mainly survives in the most difficult terrain.

Red Jungle Fowl—An erroneous record:

Red Jungle Fowl *Gallus gallus* was reported to occur in the Margala hills by the Wildlife Enquiry Committee. Khan (1976) reported 573 Red Jungle Fowl in District Hazara. This species was also reported by various other authors (Ripley 1961), Ali (1962), Siddiqui (1969) and Newland (1973). Roberts (1970) reported that White Crested Kalij was mistaken as Red Jungle Fowl by Wildlife Enquiry Committee which compiled its report perhaps on the basis of the information obtained from local people who call the White Crested Kalij as Jungli Murghi (Wild Fowl). We did survey in the Gallies exactly in the same areas where Khan (1976) counted Red Jungle Fowl. It was revealed that he also repeated the mistake of Wildlife Enquiry Committee. We, therefore, report the non-occurrence of Red Jungle Fowl atleast in Gallies.

Cheer Pheasant:

In August 1977 two members of our team Mr. A. Qaddus and Mr. Sharif reported hearing the calls of Cheer Pheasant in Machyara area at elevation about 2450 m. This bird is known as "Rayar" in Azad Kashmir and is still reported from various areas in Neelam Valley and other valleys of Azad Kashmir and even near Muzaffarabad. Its census was not attempted for the time being. It has not been reported in recent years from anywhere in Pakistan.

Acknowledgements

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EFFECT OF CONTINUOUS REMOVAL OF FIELD-RATS ON THE MOVEMENTS AND SEX RATIO OF FIELD-MICE[1,2]

G. S. MANN AND O. S. BINDRA[3]

(*With a text-figure*)

INTRODUCTION

There are many reports that the control measures against rats resulted in the increase in the population of *Mus* spp. (Barnett *et al.* 1951; Bentley 1967). Similarly, Hood (1968) reported that *Rattus norvegicus* was as numerous as *R. exulans* in fields not subjected to routine baiting, but the latter was predominant in areas with a history of baiting, and this suggested a change in species composition as a result of the baiting programme. To verify this, the influence of controlling rats on various aspects of *Mus* spp. ecobiology namely; (1) proportion of nomadic and settled individuals, (2) the duration of stay in the experimental area, (3) the migratory behaviour, and (4) the changes in sex-ratio etc. were determined to ascertain the cause for changes in the behaviour of *Mus* spp. if any.

MATERIAL AND METHODS

Studies on the movements were made by using the "capture, mark, release and recapture", method described by Davis (1964). The wonder traps fabricated at the Deccan Rat-Trap Factory, Jalgaon, Maharashtra were used for trapping. The bait used was a mixture of husked rice, pearl-millet and wheat. It was placed in the main chamber of the trap on a piece of paper. In winter, dry grass was also put in the traps to provide some protection against cold. The schedule of 10-day observations (two-weeks study of 5 days each) was adopted in all the experiments. The observations on the sex and trap-site of individuals were made during the first fortnight of each month in the undisturbed ecosystem and in the second fortnight of each month in the disturbed ecosystem (by the regular control of rats). The specific details in respect of different experiments were as follows.

1. *Measurements of field-mice in wheat and groundnut fields*:

A 6-hectare field, under a wheat-groundnut rotation, was selected. In this field, the traps were laid out at intervals of 15 metres in a grid, having 18 × 3 rows. Thus a grid of 270 × 45 metres, consisting of 54 traps was laid in a homogeneous vegetation, with a belt of more than 30 metres of similar vegetation all around. The movement studies were made throughout 1970.

2. *Movements of field-mice after the regular control of field-rats*:

The control of rats was accomplished during January 1971 to November 1972 during the first 15 days of each month. Killing of new entrants was done, by resorting to burrow fumigation, using aluminium phosphide (Celphos tablets) and by trapping. In the centre of this block, a 2-hectare area was selected

[1] Accepted May 1977.

[2] Based on Ph.D. thesis of the senior author, presently Assistant Entomologist at the University.

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to make counts of the field-mice, namely *Mus musculus bactrianus* Blyth and *Mus booduga* (Gray). The lay out and the field was the same as in the experiment on 'Movements of field-mice in wheat and groundnut fields'.

Results and Discussion

A. Movements

1. *Number of settled and nomadic field-mice*:

The number of nomadic and settled mice of both the species did not differ significantly in all the wheat crops, i.e. 1970, 1970-71 and 1971-72 and of *M. m. bactrianus* in groundnut crop of 1970. The nomadic individuals of both the species were more ($p=0.10$) than settled ones in the ground crops of 1971 and 1972 and of *M. booduga* in 1970 (Tables 1 and 2).

The number of settled individuals of *M. booduga* was significantly ($p = 0.20$) higher in the wheat crop of 1971-72 than that in the wheat crop of 1970-71, and the increase in the wheat crop of 1971-72 over that in the wheat crop of 1969-70 was still higher ($p = 0.10$). In the groundnut crop, the number of settled individuals was higher ($p = 0.10$) in 1971 than in 1970. In the groundnut crop of 1972, there was a significant ($p = 0.05$) decline in the number of settled individuals from that in the groundnut crop of 1971, and there was no difference in the population of settled individuals in the groundnut crops of 1972 and 1970.

The number of settled individuals of *M. m. bactrianus* did not differ in the three crops of wheat. However, in the groundnut crop of 1972, there was a significant ($p=0.10$) decline in the number of settled individuals of this species from that in the groundnut crop of 1970 (Table 2).

In the wheat crop of 1970, there was no real difference between the number of settled individuals of the two species, but in the groundnut season of 1970, the number of settled individuals of *M. m. bactrianus* were significantly ($p=0.20$) more than those of *M.*

Table 1

Number of settled and nomadic field-mice in a 2-ha grid of wheat and groundnut fields at Ludhiana during 1970

Period	Crop	Number of settled and nomadic field-mice in *M. booduga* Nomadic	Settled*	*M. m. bactrianus* Nomadic	Settled
February	Wheat	1	0	7	5
March	-do-	5	7	9	20
April	-do-	0	5	6	4
May	-do-	—	—	1	0
July	Groundnut	—	—	—	—
August	-do-	7	3	3	2
September	-do-	5	0	3	5
October	-do-	6	0	13	10
November	-do-	9	4	19	6

* The rats/mice trapped more than once during a trapping-period of 10-days were considered to be settled (Newsome 1970).

In June and December, observations were not recorded as the land was under preparation.

booduga (Table 1). In the wheat crop of 1970-71, there was no difference between the number of settled individuals of the two species, but in groundnut crop, the number of settled individuals of *M. booduga* was significantly ($p=0.05$) higher than that of *M. m. bactrianus*. In the wheat crop of 1971-72, the number of settled individuals of *M. booduga* was significantly ($p=0.05$) higher than that of *M. m. bactrianus*. In the next crop (groundnut) there was no difference between the number of settled individuals of the two species.

Thus the ecosystem disturbed through regular control measures against rats was more suitable for *M. booduga* than for *M. m. bactrianus*. However, there was a significant decline in the number of settled individuals of *M. booduga* during the groundnut season of 1972. This may be due to some physiological changes (Chity 1962) in the overcrowded population of this mouse in the previous crop, namely wheat of 1971-72 (Mann 1973) and this may be responsible for the low number of settled individuals during the groundnut season of 1972. In the groundnut crop of 1972, the number of settled individuals of the two species was almost equal. This may be due to increased immigration of *M. m. bactrianus* in the area vacated by the crash in the population of *M. booduga*.

TABLE 2

NUMBER OF SETTLED AND NOMADIC FIELD-MICE IN A 2-HA GRID OF WHEAT AND GROUNDNUT FIELDS AT LUDHIANA, WHERE THE FIELD-RATS WERE CONTINUOUSLY ELIMINATED

Period	Crop	Species			
		M. booduga		*M. m. bactrianus*	
		Nomadic	Settled	Nomadic	Settled
January 1971	Wheat	2	—	1	—
February 1971	-do-	7	3	5	10
March 1971	-do-	8	10	5	5
April 1971	-do-	6	1	6	16
May 1971	-do-	—	—	2	1
July 1971	Groundnut	2	—	1	—
August 1971	-do-	15	10	14	1
September 1971	-do-	28	23	11	10
October 1971	-do-	23	15	22	6
November 1971	-do-	11	11	7	1
January 1972	Wheat	15	12	—	1
February 1972	-do-	6	13	—	—
March 1972	-do-	9	10	3	1
July 1972	Groundnut	—	—	—	—
August 1972	-do-	6	2	5	—
September 1972	-do-	2	—	7	2
October 1972	-do-	4	1	6	2
November 1972	-do-	1	1	4	4

In June 1971, December 1971 and April to June 1972, observations were not recorded as the land was under preparation.

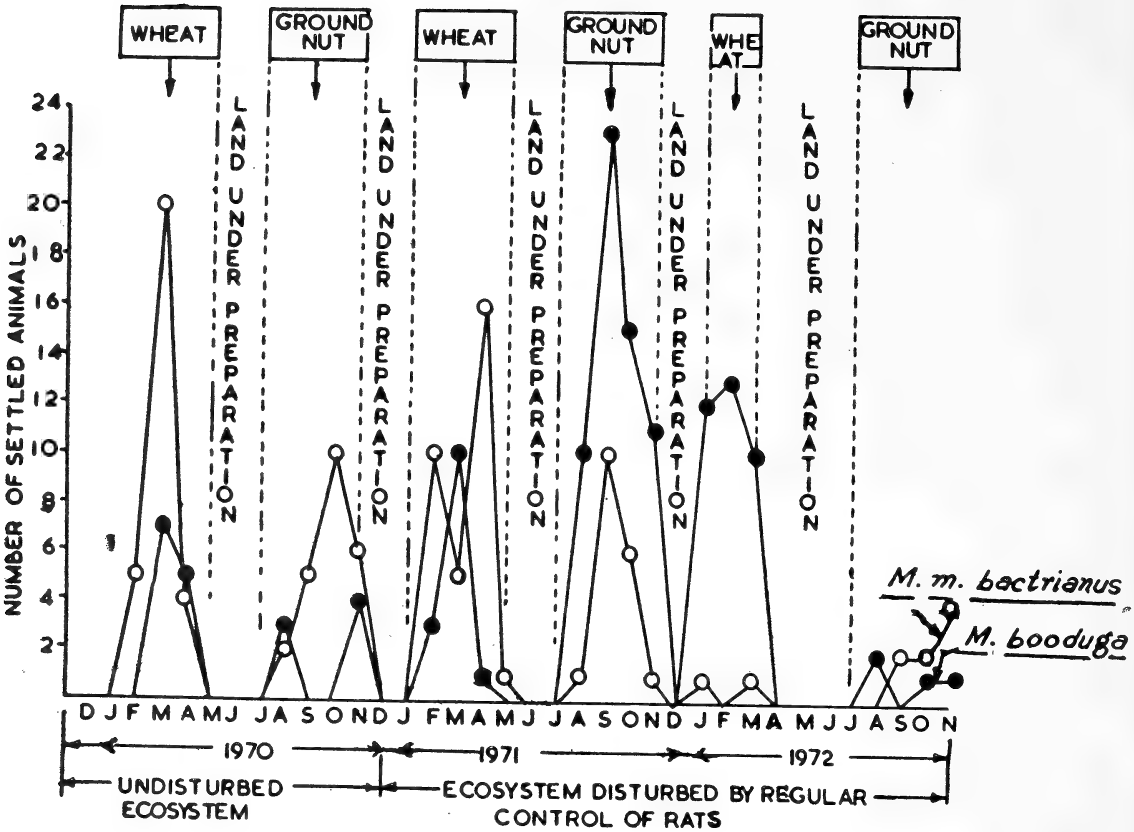

Fig. 1. Number of settled field-mice in wheat and groundnut fields at Ludhiana during 1970-72.

(2) *Duration of settled life*:

The duration for which field-mice remained settled in a 2-ha grid was as follows:

THE DURATION OF SETTLED LIFE IN DAYS

Species	Sex	Before the elimination of field-rats			Field-rats continuously eliminated		
		Number of animals observed	Mean ± S. D.	Range	Number of animals observed	Mean ± S. D.	Range
M. m. bactrianus	Male	35	7.9 ± 7.7	2–29	36	11.4 ± 13.9	2–53
	Female	22	8.6 ± 9.5	2–34	12	11.2 ± 10.7	2–33
	Average/total	57	8.2 ± 8.4	2–34	48	11.4 ± 12.9	2–53
M. booduga	Male	8	11.5 ± 10.2	2–27	36	13.6 ± 15.3	2–59
	Female	10	17.1 ± 16.0	2–48	41	15.2 ± 14.1	2–55
	Average/total	18	14.6 ± 13.7	2–48	77	14.5 ± 14.4	2–59

A comparison of the above data suggests that the period of stay of both the species remained the same in the disturbed ecosystem as in the undisturbed ecosystem.

(3) *Migration*:

The migration was studied by determining the interval after which the field-mice re-entered the experimental area and the results are summarized below:

THE INTERVAL OF RE-ENTRY (DAYS)

Species	Sex	Before the elimination of field-rats			Field-rats continuously eliminated		
		Number of animals observed	Mean	Range	Number of animals observed	Mean	Range
M. m. bactrianus	Male	11	49.0	24–150	3	96.0	61–136
	Female	11	77.0	27–121	3	29.0	25–36
	Average/total	22	63.0	24–150	6	63.0	25–136
M. booduga	Male	4	116.0	31–289	8	99.0	51–130
	Female	2	73.0	34–112	8	138.0	54–279
	Average/total	6	102.0	31–289	16	119.0	51–279

The long interval after which re-entry took place suggests that both the species of field-mice move at random, and it is only by chance that the nomadic animals re-enter a given area. A comparison of the above data suggests that the migratory behaviour of both the species remains unchanged by the change in the habitat owing to the adoption of control measures against field-rats.

(B) Sex ratio

1. *Mus musculus bactrianus* Blyth. In the undisturbed ecosystem, the males were slightly more numerous than the females in the wheat crop, whereas the two sexes were equal in number in the groundnut crop (Table 3). In the ecosystem disturbed owing to the adoption of regular control measures against rats, the males outnumbered the females in both wheat and groundnut during 1971 and 1972. In the wheat crop of 1971-72, there were no females in the experimental area, confirming no reproductive potential in the population of this mouse. In the next crop (groundnut) there was a slight build-up of reproductive potential as indicated by the sex ratio. The males were more numerous than the females (Table 4).

(2) *Mus booduga* (Gray). In the case of this mouse, the number of females remained approximately equal to or slightly in excess of the number of males both in 1970 (i.e. before the use of control measures against field-rats) and in 1971-72 (i.e. after the elimination of field-rats) (Tables 3 and 4).

From the above account of the sex ratio, it appears that the habitat changed owing to the regular control of field-rats was less suited to *M. m. bactrianus* up to the wheat season of 1971-72 than to *M. booduga*. This may be due to the interspecific relationship of the two species of *Mus* in the absence of field-rats. In the groundnut crop of 1972, the crash of *M. booduga* population (Mann 1973) led to the reinvasion of the area by *M. m. bactrianus*. This mouse then started building up its numbers, as shown by an increase in the number

TABLE 3

SEX RATIO OF FIELD-MICE AT LUDHIANA DURING 1970

Period	Crop	Number of females per male *M. booduga*	*M. m. bactrianus*
February	Wheat	—	0.33(9+3)
March	-do-	1.00(6+6)	0.76(17+13)
April	-do-	1.50(2+3)	1.50(4+6)
May	-do-	—	—(1+0)
Total/Average	-do-	1.13(8+9)	0.71(31+22)
July	Groundnut	—	—
August	-do-	2.33(3+7)	1.50(2+3)
September	-do-	0.25(4+1)	0.14(7+1)
October	-do-	2.00(2+4)	0.50(12+6)
November	-do-	3.33(3+10)	3.80(5+19)
Total/Average	-do-	1.88(12+22)	1.11(26+29)
Grand total/Average		1.50(20+31)	0.89(57+51)

Figures in the parentheses are number (male + female) of animals observed.

In June and December, observations were not recorded as the land was under preparation.

of females over males during this period as compared with the number in the wheat crop of 1970-71, the groundnut crop of 1971 and the wheat crop of 1971-72. This change in sex ratio of *M. m. bactrianus* may be due to less of interspecific competition between the two species of *Mus* owing to the crash in the population of *M. booduga* (Mann 1973).

SUMMARY

(1) These studies were made from February 1970 to November 1972 and the regular control of field-rats was done from January 1971 to November 1972.

(2) The changed ecosystem owing to the absence of the fields-rats was initially less suitable to *Mus musculus bactrianus* Blyth as evidenced by decrease in number of settled animals and also less suitable sex ratio as compared to undisturbed ecosystem, while this was reverse in *M. booduga* (Gray) and this process was continued till the wheat season of 1971-72 was over and in the next groundnut season, i.e. of 1972, there was a sudden decline in the number of settled animals of *M. booduga* and some recovery was present in *M. m. bactrianus*. This sudden decline in *M. booduga* was considered due to its high population during wheat season of 1971-72.

(3) The other characteristics of the populations, i.e. proportion of nomadic and settled individuals, period of stay and the migratory behaviour of both the species remained the same in both the habitats i.e. undisturbed ecosystem and in ecosystem disturbed by regular control of rats.

TABLE 4

SEX RATIO OF FIELD-MICE IN A 2-HA GRID, WHERE THE FIELD RATS WERE CONTINUOUSLY ELIMINATED

Period	Crops	Number of females per male	
		M. booduga	*M. m. bactrianus*
January 1971	Wheat	—(0+1)	—(0+1)
February 1971	-do-	0.43(7+3)	2.00(3+6)
March 1971	-do-	0.22(9+2)	1.83(6+11)
April 1971	-do-	0.58(14+8)	0.75(4+3)
May 1971	-do-	—(3+0)	—(—)
Total/Average	-do-	0.42(33+14)	1.62(13+21)
July 1971	Groundnut	—(1+0)	—(0+2)
August 1971	-do-	0.15(13+2)	0.33(18+6)
September 1971	-do-	0.62(13+8)	0.78(27+21)
October 1971	-do-	0.83(12+10)	1.77(13+23)
November 1971	-do-	0.60(5+3)	1.63(8+13)
Total/Average	-do-	0.52(44+23)	0.98(66+65)
January 1972	Wheat	—(1+0)	0.80(15+12)
February 1972	-do-	—(—)	0.82(11+9)
March 1972	-do-	—(2+0)	2.33(6+14)
Total/Average	-do-	—(3+0)	1.09(32+35)
July 1972	Groundnut	—(—)	—(—)
August 1972	-do-	0.25(4+1)	1.75(4+7)
September 1972	-do-	0.57(7+4)	—(2+0)
October 1972	-do-	0.83(6+5)	1.50(2+3)
November 1972	-do-	0.67(6+4)	1.00(1+1)
Total/Average	-do-	0.61(23+14)	1.22(9+11)

Figures in the parentheses are number (Male + Female) of animals observed.
In June 1971, December 1971 and April to June 1972, observations were not recorded as the land was under preparation.

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OBSERVATIONS ON *ANOPHELES* (*CELLIA*) *ACONITUS* DONITZ, 1902 (DIPTERA: CULICIDAE) IN BASTAR DISTRICT, MADHYA PRADESH[1]

ZAKIR HUSAIN HUSAINY[2]

(*With four text-figures*)

A total of 117 specimens of *Anopheles aconitus* were taken in 18 villages of Bastar District, Madhya Pradesh out of 105 surveyed in 1206 man/hours. This mosquito was mainly distributed in forests of Hot-Wet climatic belt found between 304 and over 761 m (a.s. 1.). This species appeared to be an exophilic species. The feeding was generally completed before midnight. The greatest numerical abundance was found in the Hot-Wet region in October and November. This *Anopheles* was not captured from human bait nor any anthropophilic index detected.

INTRODUCTION

Anopheles aconitus has a wide range in South East Asia stretching from Central and Eastern India, to Vietnam, Sulawasi and Timor (Soerono *et al.* 1965). This species has not been recorded from the Philippine Islands (Ramos and Darsie 1970 and Baisas 1974) and from Afghanistan (Puri 1960). Christophers (1933) pointed that the species *Anopheles aconitus,* a component of the oriental element, has a wide distribution in the oriental region to the east and extends into the Indian area upto northwest frontier or nearly so. There is practically no area in India where *Anopheles aconitus* is known as a vector however the species is the main vector of malaria in Indonesia and Indo China (Pal and Sharma 1955).

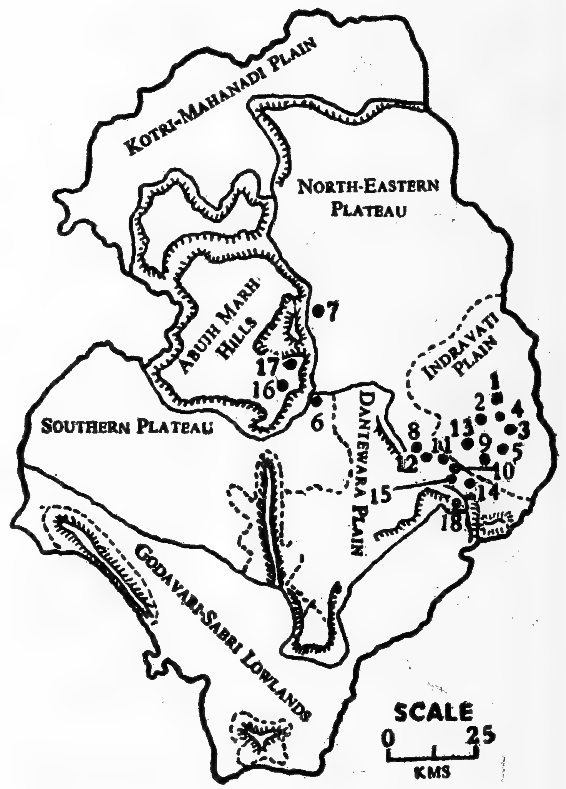

Fig. 1. Map of Bastar District showing physiographic divisions and distribution of *A. aconitus.* (For locality serials please refer text).

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Vaid & Nagendra (1964) reported malaria as hyper-endemic in Bastar District and *Anopheles culicifacies* Giles, 1901 and *Anopheles fluviatilis* James, 1902 were considered as the primary vectors of malaria. The present observations were made to study the bionomics of the anopheline fauna of Bastar District since information on this aspect from Madhya Pradesh was not available. Earlier Prakash & Husainy (1974) discussed the distribution pattern of the anopheline mosquitoes of Bastar District. In this paper some aspects of the bionomics of *Anopheles aconitus* are described.

Area and Climate

The Bastar District lies in the southeast corner of Madhya Pradesh and extends from 17°46′ to 20°34′N latitude and from 80°15′ to 82°1′ E longitude. It has an area of 39,086 sq km which falls into five main physiographical divisions (Fig. 1).

The altitude ranges from 48.5 m (village Konta) above sea level (a.s.l.) to about 1275.5 m (village Bailadila) a.s.l. This district shares the monsoon type of climate with the general Indian landmass, although the diversity of its topography does not encourage a uniform climate. There are three distinct temperature divisions namely, 22 to 24°C, 24 to 27°C and 27 to 29°C. The period from June to October covers the general rainy season. There may be two annual rainfall seasons of 152 to 178 cm and 127 to 152 cm. With the three temperature and two rainfall divisions, the district is divisible into five climatic regions (Fig. 2) (Agarwal 1968).

Materials and methods

General and routine collections were made during night and day inside houses, cattlesheds and outdoor vegetation of selected villages. In order to determine feeding times and the density buildup, all night collections were made between 1800 and 0600 hr at intervals of two hours for half an hour each. The mosquitoes were collected by an aspirator and torch light and were identified at the end of collection

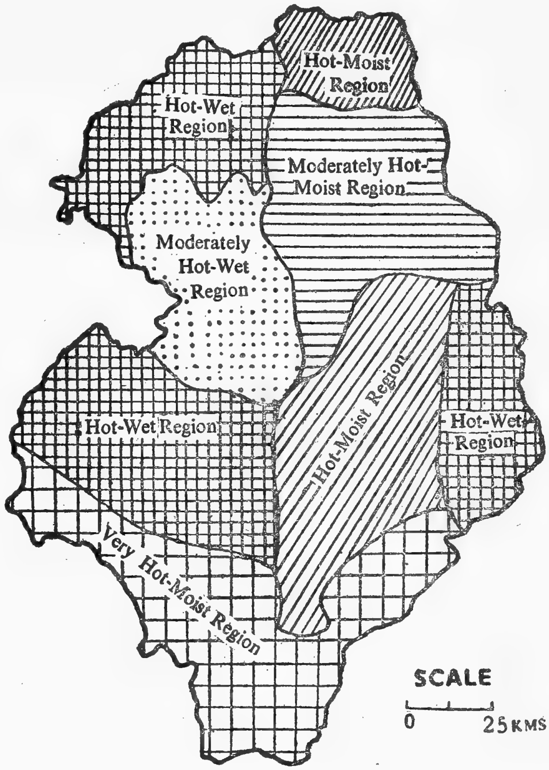

Fig. 2. Map of Bastar District showing climate regions.

on the spot in bright petromax light and their species and abdominal conditions were noted. Collections were also made by the pyrethrum spray technique inside houses to detect the indoor resting *Anopheles*. Man-biting rates were determined by placing a man as a bait and another collecting the mosquitoes actually feeding on the bait. The degree of anthropophilism/zoophilism was determined by precipi-

tin tests. The females were dissected to determine parity status and sporozoite infection.

Observations

The studies were carried out from August, 1969 to January, 1975. In this period a total of 21,716 specimens representing 19 species of *Anopheles* were captured in 1206 man/hours which had 117 specimens (25 unfed, 91 fed females, 1 male) of *Anopheles aconitus* secured from 18 villages out of 105 surveyed (Fig. 1). The numbers of specimens taken from each village is given within brackets, while the name of each village is preceded by a numeral which marks its location on the map.

Specimens Collected: 1. Asna (1); 2. Aghanpur (9); 3. Adhawal (11); 4. Hat Kachora (12); 5. Kurandi (2); 6. Barsoor (2); 7. Chote Dongar (5); 8. Paknar (1); 9. Kotamsar (18); 10. Tirathgarh (3); 11. Mamadpal (6); 12. Bispur (1); 13. Kamanar (10); 14. Kukalgur (2); 15. Darbha (21); 16. Burdum (1); 17. Tuswal (5); 18. Tongpal (7). Total = 117.

Distribution: The species was recorded from Abujh Marh Hills, North-Eastern Plateau, Indravati Plains and Southern Plateau. The altitudinal distribution ranges from 304 to over 761 m. It has been secured from Hot-Wet, Moderately Hot-Moist and Hot-Moist climatic regions of the district.

Diurnal Resting Places: *Anopheles aconitus* was not found during day time in house or cattlesheds. A total of 111 specimens (94.8%) were taken from cattlesheds in the night (Table 1).

Table 1

Composition of *Anopheles aconitus* captured at various sites in Bastar District, Madhya Pradesh

No.	Habitat	Man/Hours Spent	Nos. Collected Male	Nos. Collected Female	Per cent
1.	Cattlesheds:				
	A. From 0500 to 1800 hrs	144	0	0	—
	B. From 1800 to 0500 hrs	702	0	111	94.8
2.	Houses:				
	A. From 0500 to 1800 hrs	139	0	0	—
	B. From 1800 to 0500 hrs	117	0	0	—
3.	Outdoors:				
	From 0600 to 1800 hrs	104	1	5	5.2
	Total	1206	1	116	

Specimens in full gravid/partgravid state were never captured indoors. Out of doors, one male and five fed females (5.2 per cent) were encountered in village Adhawal in the fences alongside ricefields. It appears to be an exophilic species in Bastar District.

Feeding time of adult female: Between October, 1969 and September, 1971 a total of 147 routine all night catches were made which fetched 45 freshly fed females of *Anopheles aconitus* resting in cattlesheds of the study villages at different hours of night collection. The biting cycles (Fig. 4) are prepared from the combined data for each hour from collections in all seasons. It was seen that *Anopheles aconitus* generally completed feeding before midnight. In November, this mosquito was

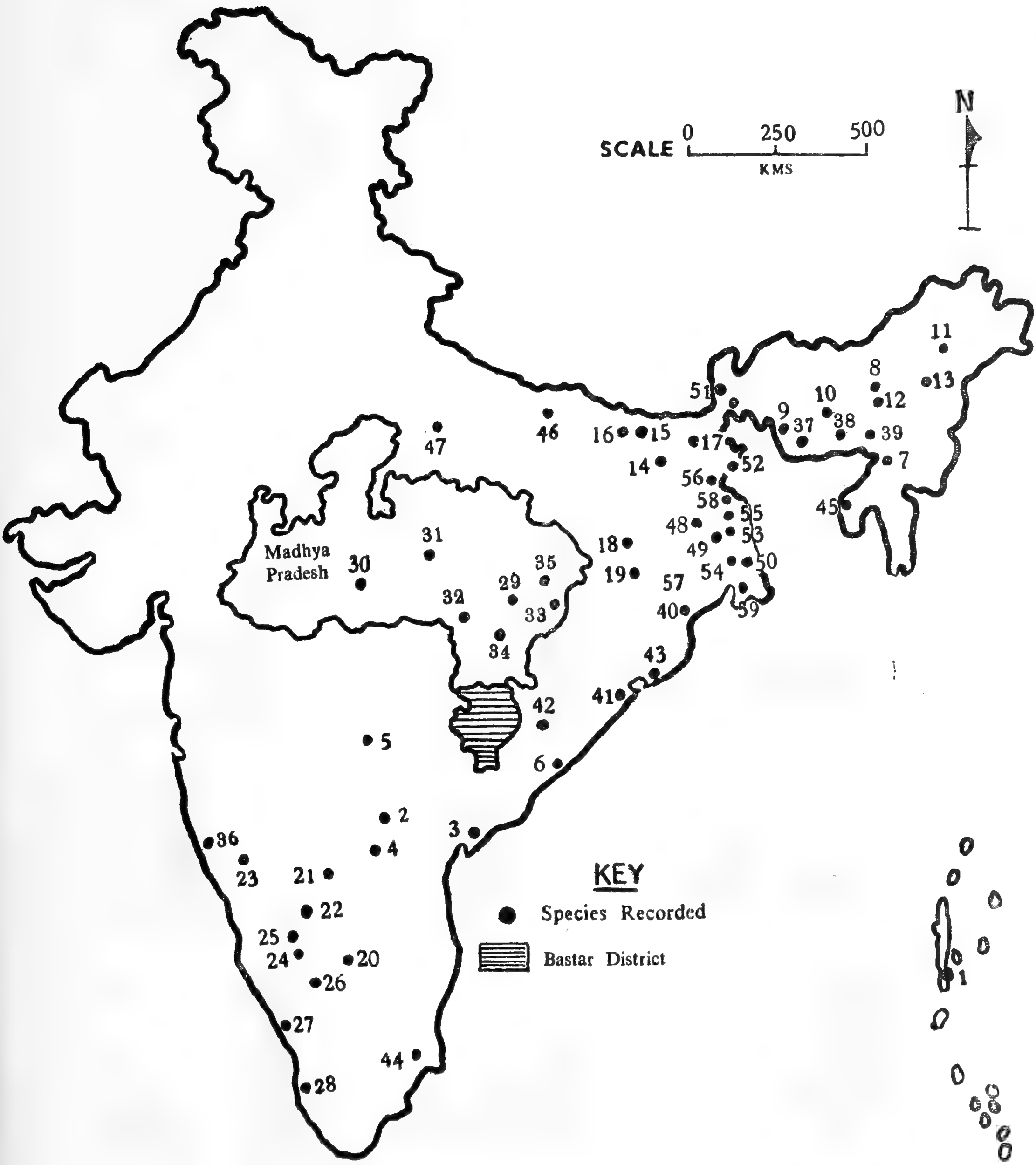

Fig. 3. Map of India showing distribution of *A. aconitus*. (For locality serials please refer text).

most active between 1800 and 2000 hr and the numbers caught declined progressively through the night. In July and December slight activities were noted beyond midnight also.

Density Build Up: It was not regularly taken in village Darbha between October, 1969 and September, 1970. Out of a total of eight examples captured in this period, seven were found in October while a solitary female was taken in June.

Seasonal Prevalence: The majority of specimens of *Anopheles aconitus* (76) were taken in October and November. In other months the species was less numerous while in the peak of winter (January) and summer (May) this species was not encountered (Table 2).

Area of Abundance: The majority of the villages positive for the species are located in the Indravati Plains, 457 to 609 m elevation and Hot-Wet climatic region. Table 3 shows the collection of *Anopheles aconitus* in different climatic belts of the district. It will be seen that 70 examples (59.8%) were taken in the Hot-Wet Region. This area is mostly covered with forest. In Hot-Moist region 36 examples (34%) were captured. This belt receives less rainfall than the Hot-Wet. In Moderately Hot-Wet and Moderately Hot-Moist Regions, which are coolest areas of the district, *Anopheles aconitus* was less numerous, while in the Very Hot-Moist Region where least rainfall and highest temperatures of the district

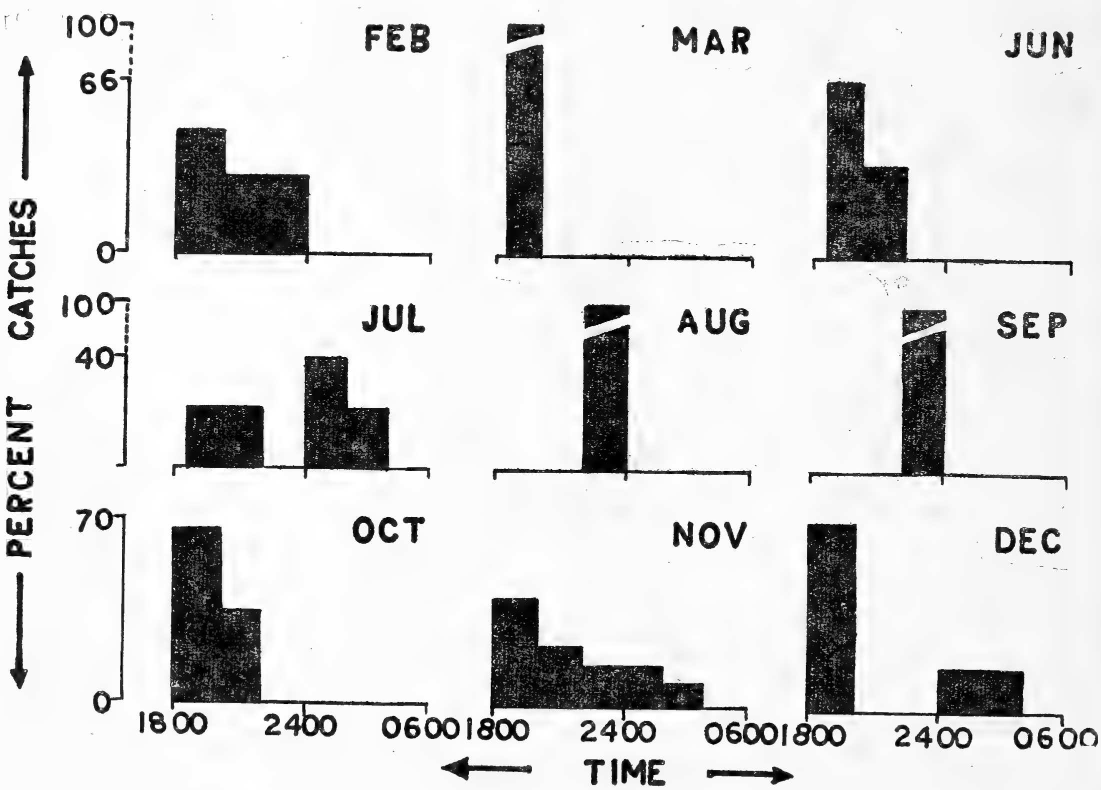

Fig. 4. Feeding times of *A. aconitus* female adults in Bastar District, Madhya Pradesh.

are recorded, this anopheline was not captured.

Man Biting Rate: No female of *Anopheles aconitus* was found biting human bait in the houses of three villages where man biting rates were determined for 80 man/hours although 67 anopheline females belonging to five species were captured along with 263 culicine females.

Anthropophilic Index: A total of 14 smears of the gut contents proved to be zoophilic in the precipitin test. These females were captured in the cattlesheds of three villages Tongpal, Darbha and Kukalgur.

Dissections: A total of 102 females which were dissected, had 81 nulliparous females indicating their fresh arrivals for feeding. The remainder (21) were found one parous proving the age of those females of less than a week. Sporozoite of *Plasmodium* spp. were not found in the salivary glands of any female dissected.

TABLE 2

SEASONAL PREVALENCE OF *Anopheles aconitus* AT THREE PLACES IN INDIA

No.	Month	Bastar District* Actuals	Nilgiris District** Per man Hour	Nilgiris District** Per man Hour	Puri, Orissa*** Actuals
1.	January	00	—	—	75
2.	February	07	0.2	—	47
3.	March	04	0.1	—	10
4.	April	07	0.2	—	1
5.	May	00	—	—	8
6.	June	05	0.2	0.1	1
7.	July	05	0.2	—	1
8.	August	06	0.2	—	17
9.	September	04	0.1	0.1	8
10.	October	23	0.8	—	21
11.	November	53	1.5	0.1	131
12.	December	03	0.1	0.1	100
	Total	117			420

* Present studies. ** Russell and Jacob (1942). *** Panigrahi (1942).

TABLE 3

COMPOSITION OF *Anopheles aconitus* COLLECTED IN VARIOUS CLIMATIC BELTS OF BASTAR DISTRICT, MADHYA PRADESH

No.	Climatic Region	No. collected	Per cent
1.	Moderately Hot-Moist Region	5	5.6
2.	Moderately Hot-Wet Region	6	5.6
3.	Hot-Wet Region	70	59.8
4.	Hot-Moist Region	36	29
5.	Very Hot-Moist Region	0	—

DISCUSSION

The distribution of the oriental element *Anopheles aconitus* was noted in forest area at higher altitudes of the district. In plain areas, it was not encountered. It is not a widely distributed and numerically dominant species in the district. Russell & Jacob (1942) secured *Anopheles aconitus* larvae upto 1219 m (a.s.l.) in Nilgiris District, India. The present distribution of this species in India is shown in Fig. 3 (Puri 1955). The mosquito appeared to visit cattlesheds in the night while diurnally it took asylum out of doors. Büttiker (1958) described this behaviour as a complete deliberate type "A" exophily (Endophagy of Senior White). Muirhead-Thomson (1963) noted in the inland areas of Java that very few specimens of *Anopheles aconitus* rested during day time in houses and very few are secured in the usual type of cattleshed which has a roof but no walls, and a great majority of *Anopheles aconitus* are found outdoors in the banks of streams and other sheltered places at densities much higher than in houses, and about 23% of these outdoor resting females are found to be freshly fed. Russell & Jacob (1942) took one female each in houses and mixed dwellings and two females in cattlesheds of Nilgiris west from February, 1940 to January, 1941. Pal & Sharma (1955) stated that adult fe-

males of *Anopheles aconitus* as a rule, feed and rest indoors.

Though feeding times in individual months varied however this was generally completed before midnight. This *Anopheles* was taken all round the year except during the peak of winter and summer. It appears that peaks of rain and extreme temperatures, both low and high, discourage the numerical abundance of *Anopheles aconitus*. The main period of abundance may be considered in early winter after the rains have stopped. Russell & Jacob (1942) while working in Nilgiris west, recorded this species in equal numbers in June, September, November and December. Panigrahi (1942) reported the prevalence of *Anopheles aconitus* in Puri, Orissa, throughout the year with peak densities in November after which it declined. This mosquito was not numerically dominant in the anopheline fauna, for its 117 specimens captured formed only 1.9% of the total collection (21,716 specimens) of the district. Panigrahi (1942) took 45,123 examples of anopheline mosquitoes in Puri, Orissa, which had 420 specimens of *Anopheles aconitus* (0.9% of total).

No anthropophilic index was detected in *Anopheles aconitus* nor was it taken from human bait. Pal & Sharma (1955) pointed out that the females readily feed on man. In Java, biting takes place indoors and outdoors and can reach extremely high levels if the human bait is in the vicinity of cattle (especially water buffalo) (Soerono *et al.* 1965). Anthropophilic indices of 11.2% (caught from houses) and 0.5% (caught from stables) have been recorded from Indo-China and 12% (cattle present) and 61% (cattle scarce) from Indonesia (Pal & Sharma 1955). Sporozoite infection was not found in salivary glands of females dissected. None of the earlier records suspects this *Anopheles* as a vector of malaria in India although Senior White *et al.* (1943) found sporozoite infection in the salivary glands of two female adults of this species out of 951 from Coastal Orissa, dissected.

Acknowledgement

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A STUDY OF THE AQUATIC AND MARSHLAND PLANTS OF JHALAWAR DISTRICT, RAJASTHAN[1,2]

V. Singh[3]

The present study gives an account of the floristic composition, phenology, ecology and detailed distribution of aquatic and marshland vegetation of Jhalawar district. The area has remained under-explored on account of its lack of facilities. Important aquatic habitats of the area have been selected for detailed study and a description of each habitat alongwith characteristic species occurring there, has been given. The hydrophytes have been classified into six life-forms based on their contact with soil, water and air. Proportion of monocots to dicots with regard to species (1:0.8) is interesting as the hydrophytic vegetation is represented by a better number of monocotyledons in this area. Four species have been mentioned as new records for Rajasthan. Detailed distribution of the species in the area surveyed has been tabulated and important aquatic and marshland communities are described.

Introduction

The flora of Rajasthan has been studied in great detail since the publication of Blatter and Hallberg's (1918-21) "The Flora of the Indian Desert". In recent years, studies have also been undertaken on the hydrophytic and marshland flora of the terrain (Ratnam & Joshi 1952; Sarup 1958, 1961; Nair & Kanodia 1959; Vyas 1962, 1964; Gupta 1966; Maheshwari & Singh 1974; see also Biswas & Calder 1937; Subramanyam 1962; Majumdar 1971). There is, however, a lacuna in our knowledge of the structure and composition of aquatic and marshland flora of Jhalawar district in south-eastern part of Rajasthan. The present paper includes fairly comprehensive data on the floristic composition, phenology, ecology and the distribution of hydrophytes from Jhalawar district. The region was surveyed in different seasons during the years 1968 to 1973 and the specimens collected during this study are preserved in the Herbarium of Floristic Botany Division, National Botanic Gardens, Lucknow (LWG).

Location, soil and climate

Jhalawar district is situated in the southeast corner of Rajasthan at the edge of Malwa plateau between 23°45′ and 24°52′N. latitude, and 75°27′ and 76°56′ E. longitude. It is bounded on the north by Kotah district, on the east, west and south by Madhya Pradesh. The district occupies an area of about 2310 sq. kilometres and is situated at an altitude of 302 m above m.s.l.

The climate of the area is dry monsoonic and shows three well marked seasons, namely rainy, winter and summer seasons. During the months of May and June, the mean maximum temperature of 43°C has been recorded. The mean minimum temperature of 7°C has been recorded in the months of December and January. Out of the total annual rainfall, the

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[2] A part of Ph.D. thesis approved by Meerut University, Meerut.

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months of July to October receive 700-900 mm of rains which is 99% of the total fall of the year. The rains are infrequent during winter. The soils can be broadly classified into clay and clay-loam types. The clay content varies from 25-48%, and shows 25-50% silt and 25-50% sand. The dispersion co-efficient has been found to be very low, thus indicating a good water-table structure and a resistance to detachability by flood water.

Habitats and plant associations

The study was conducted over a greater part of the district with special reference to the following habitats.

Rivers and streams: The rivers and streams of this district belong to Chambal system and they generally flow from south to north. For the sake of convenience, they may be classified into two groups—(i) Western rivers, (ii) Eastern rivers. Ahu and Kalisindh, with their many tributaries, belong to the first category. The source of Ahu is a tank in Madipur tehsil of Madhya Pradesh. It flows northwards forming boundaries between Dag and Pirawa and Pachpahar and Jhalarapatan tehsils of the district. On meeting Mukandara hills, the river is deflected north to east and then abruptly changes its course to south-east to join Kalisindh near Gagrain. The important tributaries of Ahu include Piplaj, Kyasri, Kantli and Rewa. Kalisindh, entering the district from Madhya Pradesh, flows northwards forming boundaries between Bakani and Jhalarapatan tehsils. Its important tributary is Chandrabhaga which is dammed near Mundliakheri to form a tank. It joins Kalisindh near Khandia village.

Parwan is the important river of the second group. It is formed by the combination of Ajnar and Ghorapachar rivers which flow northwards and meet near Manoharthana town. Parwan flows north-westwards through Manoharthana tehsil and then turns westwards forming the northern boundary of Aklera tehsil. Eventually, it joins the Kalisindh. On its way it receives Kalikhar, Newaj, Ghar, Ujar, Nagli and Roopli tributaries.

During the monsoon season, the rivers flow very swiftly, regularly causing floods. But, by the summer, they are almost all dry excepting a few places where a trickle of water is preserved in the pools which are the most favourable spots for the growth of aquatics. Though, the river beds are rocky with big boulders, they carry a considerable amount of sand which is poor in humus, porosity and nitrate content, and is rich in carbonates and chlorides. The soils, geology, seepage, silting, substratum, physiochemical properties of water and the biotic interferences are almost identical in all the rivers. The true aquatic species are very poorly represented in these habitats, and no where in the district attached aquatics dominate the vegetation. The free-floating or suspended submerged forms dominate the aquatic plant communities of the rivers and their tributaries. The paucity of aquatic species, especially of attached forms, is mainly due to the rocky bottom of the rivers.

The amphibious emergent species are comparatively better represented in these habitats. The vegetation is more luxuriant and continuous along the banks of the rivers, perhaps, due to better soil formation. However, patches of emergent forms, particularly *Cyperus, Fimbristylis, Scirpus* and *Crinum* together with *Hydrilla, Ceratophyllum, Zannichellia* and *Potamogeton,* may be noted in midstream also. Some exposed rocks in the centre of the rivers are covered with *Rotala serpyllifolia* (Roth) Bremek. This indicates that there is no particular zonation of plants in the rivers. However, *Nymphaea* and *Nymphoides* disappear

gradually towards the shore. The following plant associations have been noted in the rivers at different places.

Ceratophyllum-Hydrilla-Nymphoides
Hydrilla-Zannichellia-Potamogeton
Hydrilla-Nymphoides-Nymphaea
Potamogeton-Ceratophyllum-Vallisneria
Cyperus-Fimbristylis-Scirpus-Zannichellia
Polygonum-Cyperus-Scirpus
Marsilea-Fimbristylis-Polygonum
Ammannia-Alternanthera-Eclipta
Phyla-Eclipta-Bacopa-Marsilea
Cyperus-Phyla-Eclipta
Ammannia-Caesulia-Bacopa-Scirpus
Typha-Caesulia-Cyperus

Besides these, there are pure communities of *Eichhornia crassipes* (Mart.) Solms, *Potamogeton pectinatus* L., *Rotala rotundifolia* (Ham.) Koehne and *R. serpyllifolia* (Roth) Bremek. Members of *Cyperaceae* are sparsely distributed among the rocks in the rivers.

Tanks and Lakes: There are two artificial lakes—Kadila and Mansarowar in the district which are formed by building embankments between two parallel ridges of Mukandara in the north-east of Asnawar town. These lakes support thick growth of wetland plants and only few true aquatics. The other large sized tanks of the area are Chandra Sarowar—in the south of Jhalawar, Durgapura tank—near Durgapura village, Kishan Sagar—in the west of Jhalawar, Tandia tank—near Khandia village, Gomti Sagar—near Jhalarapatan, Mandawar tank—near Mandawar village, Gordhanpura tank—near Gordhanpur village, Kadila tank—in the north-west of Asnawar etc. In Pachpahar tehsil, Naka-sarna and Niwas-ghatod, and in Bakani tehsil, the Molkia are the notable tanks. Most of these tanks lie in depressions and are fed by a number of 'Nallas' during the rainy season. They are being used for irrigation and are exposed to heavy biotic interferences by the way of weed removal, washing of clothes and animals. They are more or less naked in the centre. However, the margins often have a sparse growth of *Hydrilla verticillata* (Linn. f.) Royle, *Vallisneria natans* (Lour.) Hara, *Potamogeton crispus* Linn. and *Zannichellia palustris* Linn. together with certain algae (*Spirogyra* sp. and *Oedogonium* sp.). The free floating plants are mostly represented by *Spirodela polyrrhiza* Schleid., *Lemna paucicostata* Hegelm. and *Azolla pinnata* R. Br. Occasionally, the species of *Nymphaea* and *Nymphoides* may also be noted in these habitats. The marshy banks support comparatively thick growth of emergents, particularly the members of *Cyperaceae* together with many creeping plants like *Phyla nodiflora* (L.) Greene, *Alternanthera sessilis* (L.) DC., *Eclipta prostrata* (L.) Linn., *Marsilea minuta* L. etc.

The interesting tanks from hydrophytic vegetation point of view are situated in the villages of Dalanpur, Bakani, Brahmpura, Kushalpura, Patlai, Rijol, Richwa, Dhudalia, Ratanpura, Singhpur, Unhel, Semli, Sheopura, Panwasa, Bager, Bordi, Jolpa, Mirsoli, Adakheri, Govindpura, Koldi-choti and Sherpura. The depth of these tanks varies from 1-3 feet and they are mostly fed by run off water during rainy season. They hold a variety of aquatic and amphibious plants. The vegetation of some of these tanks shows an interesting zonal distribution. The gently sloping marginal zone exhibits a carpet of marshland species; the shallow middle zone supports a rich emergent vegetation; and the central zone, which is always under water, is favourable for the attached and floating aquatic forms.

A. Central zone associations:

1. *Zannichellia-Hydrilla-Nymphoides*
2. *Nymphaea-Ceratophyllum-Potamogeton*

3. *Azolla-Spirodela-Lemna*
4. *Nymphaea-Nymphoides-Zannichellia*
5. *Nymphaea-Hydrilla*
6. *Trapa-Hydrilla-Ceratophyllum*

B. Middle zone associations:

1. *Typha-Aeschynomene-Fimbristylis-Hydrilla*
2. *Cyperus-Scirpus-Ceratophyllum*
3. *Typha-Caesulia-Cyperus-Zannichellia*

C. Marginal zone associations:

1. *Phyla-Marsilea-Eclipta*
2. *Cyperus-Ammannia-Alternanthera*
3. *Ammannia-Alternanthera-Veronica*
4. *Cyperus-Phyla-Marsilea*
5. *Fimbristylis-Scirpus-Bacopa-Alternanthera*

Besides these, at certain places *Eichhornia crassipes* (Mart.) Solms, *Nechamandra alternifolia* (Roxb.) Thw. and *Potamogeton pectinatus* Linn. occur in pure stands.

Puddles, Ponds, Nallas and Rice-fields: There is a number of shallow bodies of water distributed throughout the area in the form of Puddles and Ponds. The vegetation of these habitats is dominated by the species of *Fimbristylis, Cyperus, Aeschynomene, Typha, Monochoria, Limnophila, Veronica, Polygonum* etc. Among the floating forms, the species of *Lemna, Spirodela, Hydrilla, Zannichellia, Ceratophyllum, Eichhornia, Nymphoides* etc. are more common. The species of *Nymphaea* represent the group of attached forms. At certain places *Potamogeton pectinatus* Linn., *Nechamandra alternifolia* (Roxb.) Thw., *Pistia stratiotes* L. and *Typha angustata* Bory & Chaub. form pure communities. It is also interesting to note that certain ponds devoid of aquatic and marshy vegetation when with water, maintain luxuriant growth of *Glossostigma spathulatum* (Hook. ex Wt.) Arn. ex Benth., *Dentella repens* (L.) Forsk. and *Polygonum plebeium* R. Br. as soon as the habitats become marshy.

There are many 'nallas' in the area which feed the large tanks and lakes. They maintain a thick growth of semi-aquatic or marshy plants in the post monsoon period. The most common species are *Aeschynomene, Typha, Hygrophila, Caesulia, Marsilea, Ottelia, Eclipta, Alternanthera, Bacopa, Veronica, Ipomoea, Ammannia, Bergia, Monochoria* etc. At certain places, where a trickle of water is preserved, an association of *Potamogeton-Zannichellia-Hydrilla* was noted. It is interesting to note that, though, the seeds of the species growing in 'nallas' are brought to the respective tanks fed by them, yet, the hydrophytic flora of the tanks is very poor. This is, perhaps, due to the rocky bottom, poor aeration and wide amplitude of water in the tanks and lakes.

Rice-fields are other favoured spots for the growth of aquatic and marshland plants. *Utricularia inflexa* Forsk. var. *stellaris* (Linn. f.) Taylor, *U. gibba* L. subsp. *exoleta* (R. Br.) Tayl., *Spirodela polyrrhiza* Schleid., *Lemna paucicostata* Hegelm., *Ammannia baccifera* L. and the members of *Cyperaceae* together with *Oryza sativa* L. behave like a community. It is also interesting to note that the seeds of weed species grow a few days later than crop-seeds and complete their life cycle before the crop is harvested, except the few members of *Cyperaceae* like *Fuirena wallichiana* Kunth. No zonal distribution of plant communities was noted in these habitats.

TABLE 1

SHOWING THE HABIT, FLOWERING PERIOD AND DETAILED DISTRIBUTION OF HYDROPHYTES AND MARSHLAND SPECIES*

Species	Habit	Flowering period	Localities 1	2	3
MARSILEACEAE					
Marsilea minuta Linn.	B	Aug.-Oct.	+	+	+
SALVINIACEAE					
Azolla pinnata R. Br.	A	Not seen	–	+	+
EQUISETACEAE					
Equisetum ramosissimum Desf. subsp. *ramosissimum*	E, F	Not seen	+	–	–
NYMPHAEACEAE					
Nymphaea nouchali Burm. f.	B	July-Nov.	+	+	+
N. stellata Willd.	B	July-Nov.	+	+	+
ELATINACEAE					
Bergia ammanioides Roxb.	E, F	Oct.-Dec.	+	+	+
B. capensis Linn.	E, F	Aug.-Nov.	–	–	+
PAPILIONACEAE					
Aeschynomene indica Linn.	E	July-Oct.	+	+	+
LYTHRACEAE					
Ammannia baccifera Linn.	E, F	July-Oct.	+	+	+
A. multiflora Roxb.	E, F	Aug.-Nov.	–	+	+
Rotala indica (Willd.) Koehne	E, F	Oct.-Feb.	–	–	+
R. rotundifolia (Ham.) Koehne	A	Dec.-March	+	–	–
R. serpyllifolia (Roth) Bremek.	F	Aug.-Nov.	+	–	–
ONAGRACEAE					
Ludwigia adscendens (Linn.) Hara	A	Aug.-Nov.	–	+	+
L. perennis Linn.	E, F	Aug.-Nov.	+	+	+
TRAPACEAE					
Trapa bispinosa Roxb.	A	Sep.-Dec.	–	+	+
RUBIACEAE					
Dentella repens (Linn.) Forst.	F	Jan.-March	–	+	+
COMPOSITAE					
Caesulia axillaris Roxb.	E, F	Sept.-Dec.	+	+	+
Eclipta prostrata (L.) Linn.	E, F	Most part of year	+	+	+
Sphaeranthus indicus Linn.	F	Oct.-Feb.	+	–	–
Spilanthes paniculata Wall. ex DC.	E	Dec.-April	–	–	+
LIMNANTHACEAE					
Nymphoides cristatum (Roxb.) Ktze.	B	Jan.-March	+	+	+

Species	Habit	Flowering period	Localities 1	2	3
N. indicum (Linn.) Ktze.	B	Jan.-March	+	+	+
HYDROPHYLLACEAE					
Hydrolea zeylanica Vahl	E	Sept.-Oct.	–	–	+
BORAGINACEAE					
Rotala aquatica Lour.	E	Oct.-Feb.	+	–	–
CONVOLVULACEAE					
Ipomoea aquatica Forsk.	A, F	Dec.-March	+	+	+
SCROPHULARIACEAE					
Bacopa monniera (Linn.) Pennell	E, F	Sept.-Dec.	+	+	+
Glossostigma spathulatum (Hook. ex Wt.) Arn. ex Benth.	F	Dec.-Feb.	–	–	+
Limnophila indica (Linn.) Druce	E	Oct.-April	+	–	+
Veronica anagallis-aquatica Linn.	E, F	Jan.-March	+	+	+
LENTIBULARIACEAE					
Utricularia inflexa Forsk. var. *stellaris* (Linn. f.) Taylor	A	Oct.-Dec.	–	–	+
U. gibba Linn. subsp. *exoleta* (R. Br.) Tayl.	A	Jan.-April	–	+	+
ACANTHACEAE					
Hemiadelphis polyspermus Nees	F	Sept.-March	+	–	+
Hygrophila auriculata (Schumach.) Heine	E, F	Oct.-March	–	+	+
VERBENACEAE					
Phyla nodiflora (Linn.) Greene	F	Throughout year	+	+	+
AMARANTHACEAE					
Alternanthera paronychioides St. Hil.	F	Sept.-Jan.	–	+	+
A. sessilis (Linn.) DC.	F, E	Most part of the year	+	+	+
POLYGONACEAE					
Polygonum barbatum Linn. subsp. *gracile* Dan.	E	Aug.-Dec.	+	+	+
P. glabrum Willd.	E	Aug.-Nov.	+	+	+
P. plebeium R. Br.	F	Aug.-Nov. & March-June	+	+	+
CERATOPHYLLACEAE					
Ceratophyllum demersum Linn.	C	July-Oct.	+	+	+
HYDROCHARITACEAE					
Hydrilla verticillata (Linn. f.) Royle	C	July-Oct.	+	+	+
Nechamandra alternifolia (Roxb.) Thw.	C	Sept.-Jan.	–	+	+
Ottelia alismoides (Linn.) Pers.	D	Jan.-March	+	–	+
Vallisneria natans (Lour.) Hara	D	Jan.-April	+	+	+
AMARYLLIDACEAE					
Crinum defixum Ker-Gawl.	E	Most part of the year	+	–	–

Species	Habit	Flowering period	Localities 1	2	3
PONTEDERIACEAE					
Eichhornia crassipes (Mart.) Solms	A	May-Oct.	+	+	+
Monochoria hastata (Linn.) Solms	E	Aug.-Nov.	–	+	+
M. vaginalis (Burm. f.) Presl.	E	Aug.-Nov.	–	–	+
TYPHACEAE					
Typha angustata Bory & Chaub.	E	.July-Aug.	+	+	+
ARACEAE					
Pistia stratiotes Linn.	A	April-June	–	+	+
LEMNACEAE					
Lemna paucicostata Hegelm.	A	Not seen	–	+	+
Spirodela polyrrhiza Schleid.	A	Oct.-Jan.	+	+	+
POTAMOGETONACEAE					
P. perfoliatus Linn.	D	Feb.-May	+	+	+
P. pectinatus Linn.	C	Jan.-March	+	–	+
P. perfoliatus Linn.	D	Feb.-May	+	–	–
ZANNICHELLIACEAE					
Zannichellia palustris Linn.	C	Feb.-March	+	+	+
NAJADACEAE					
Najas minor Linn.	C	Sept.-Dec.	+	–	–
ERIOCAULACEAE					
Eriocaulon quinquangulare Linn.	E, F	Dec.-April	–	+	+
CYPERACEAE					
Cyperus alopecuroides Rottb.	E	Aug.-Dec.	+	+	+
C. compressus Linn.	E, F	Aug.-Dec.	+	+	+
C. digitatus Roxb.	E, F	July-Sept.	+	–	–
C. difformis Linn.	E, F	Sept.-Dec.	+	+	+
C. eleusinoides Kunth	E	Sept.-Feb.	+	+	+
C. exaltatus Retz.	E	Aug.-Nov.	+	–	+
C. flavidus Retz.	E, F	Dec.-March	+	+	+
C. iria Linn.	E, F	Aug.-Nov.	+	+	+
C. michlianus (L.) Link subsp. *pygmaeus* (Rottb.) Asch. & Graebn.	F	July-Oct.	+	+	+
C. niveus Retz.	F	July-Nov.	–	+	–
C. pangorei Rottb.	E	Dec.-April	+	+	+
C. pumilus Linn.	F	Aug.-Nov.	+	–	+
C. rotundus Linn.	E, F	July-Dec.	+	+	+
Eleocharis atropurpurea Kunth	E	Jan.-May	–	–	+
Fimbristylis aestivalis Vahl	E, F	Sept.-Dec.	+	+	+
F. ovata (Burm. f.) Kern	F	Aug.-Oct.	–	–	+
F. quinquangularis Kunth	E, F	Aug.-Nov.	+	+	+
Fuirena wallichiana Kunth	E, F	Sept.-Jan.	–	–	+

Species	Habitat	Flowering period	Localities 1	2	3
Scirpus affinis Roth	E	Jan.-May	–	–	+
S. littoralis Schrad.	E, F	Feb.-April	+	–	+
S. roylei (Nees) Parker	E, F	July-Nov.	–	–	+
S. supinus Linn.	E, F	Oct.-Dec.	+	+	+
GRAMINEAE					
Echinochloa colonum (Linn.) Link	E, F	Jan.-Oct.	+	+	+
Hygroryza aristata Nees	A	April-June	–	+	–
Isachne miliacea Roth	E	Nov.-Feb.	–	–	+
Oryza sativa Linn.	E, F	Oct.-Nov.	–	–	+
O. rufipogon Griff.	E	Sept.-Nov.	–	–	+
Paspalidium punctatum Stapf	E	Sept.-Nov.	+	+	+
Phragmites maxima Blatt. & McC.	E	Sept.-Jan.	+	–	–

* Explanation of symbols:
+ = present; – = absent; A = Free floating; B = Attached with floating leaves and/or shoots; C = Suspended submerged; D = Attached submerged; E = Aquatic or amphibious emerged; F = Marshland plants; 1 = Rivers and streams; 2 = Tanks and lakes; 3 = Puddles, ponds and rice-fields.

Discussion

The area, apparently unsuitable for the growth of luxuriant vegetation, is rich in aquatic and marshland species. The present study shows that 88 species belonging to 56 genera and 34 families inhabit the riverain and marshland areas of the district. The floristic composition of the vegetation is as follows:

	Family	Genera	Species
Pteridophytes	3	3	3
Monocotyledones	12	26	47
Dicotyledones	19	27	38

This indicates that the monocots are less represented by their families and genera, and are better represented in their species. Of these species 27 show restricted distribution and are confined to a single habitat and 40 occur throughout the area. The amplitude of water level, physical and chemical nature of the substrata and water, and more specially the biotic activities seem to control the distribution of these species. The type of bottom is also very important in the ecesis of hydrophytes. The poorest growth occurs on gravel or rock, whereas the best growth is organic, silty or loamy soils. In this area, 12 species are free floating, 5 attached with floating leaves and/or shoots, 6 suspended submerged, 4 attached submerged, 21 aquatic or amphibious emerged, 12 marshland and 28 species occur both in aquatic and marshy habitats. About five species form their communities and the rest are either sparsely distributed or grow in different associations. The six dominent families according to the number of species are *Cyperaceae* (22), *Gramineae* (7), *Lythraceae* (5), *Scrophulariaceae* (4), *Hydrocharitaceae* (4), *Compositae* (4).

The species rather uncommon in the flora of Rajasthan but collected during the course

of present study are: *Spilanthes paniculata* Wall. ex DC., *Fimbristylis ovata* (Burm. f.) Kern, *Fuirena wallichiana* Kunth and *Oryza rufipogon* Griff.

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DISTRIBUTION, HABITAT AND STATUS SURVEY OF THE LIONTAILED MACAQUE, *MACACA SILENUS* (LINNAEUS)[1]

G. U. KURUP[2]

(*With four text-figures*)

The present distribution range of the liontails south of 21°N, their major habitats and the status of populations in each of these habitats are reported, based on surveys carried out during last six years. It is seen that south of 12°N, the distributional range is between 11°30′ and 8°21′N, i.e. from south-western face of Nilgiris down to Kalakkadu slopes in the Agasthya Ranges of southern spurs. Distribution within this range has now come to be in extremely localised, widely discontinuous patches holding only very sparse populations in each. A tentative estimate would place the liontail population at about 50 troops of 570 individuals south of 11°30′N. Assuming another five troops in habitats lying north of this range total estimated liontail population is placed at 55 troops of about 800 individuals in areas covering about 2800 sq km in the Western Ghats. Structure of the rainforest habitat, variants of vegetational features and phenological succession are given. Major conservation problems faced by liontails are identified as habitat conversion and eventual destruction on the one hand and direct decimation on the other. A set of recommendations involving both immediate and long range measures, necessary for liontail survival is also offered.

The status of the Liontailed Macaque, *Macaca silenus* (Linnaeus) one of the rarest and most beautiful of the macaques, confined to the Western Ghats of India has been a cause for concern. Inhabiting dense evergreen forests, the species has never been common and there is very little information available, although surprisingly enough it does well in captivity. Jerdon (1874) gave its range as "the more elevated forests of the Western Ghats of India from 14°N to the extreme south but most abundant in Cochin and Travancore." Blanford (1888), Pocock (1939) & Prater (1965) mostly relied on Jerdon for their accounts of the species. Jerdon also stated that it is said to occur still further north up to Goa (15°N) but could not authenticate it. Much later, Editors, *JBNHS* (1956) reported a sighting on the Anshi Ghat between Kadra and Kumbharwada *c.* 15°N lat. which remains the northern most reported range limit. Apart from Jerdon's account there are only a few other original accounts of this species. Kinloch (1923) describes them in Nelliampathy hills, Webb-Peploe (1947) gives observations on them in south Tirunelveli hills and Hutton (1949) deals with the species in the High Wavy mountains, the eastern spurs of the Western Ghats in Madura district of Tamilnadu. Sugiyama (1968) made a two month study of the ecology of the species at Panniyar in the High ranges of Kerala near Munnar and Karr (1973) gave some notes on the species at Manjolai in the Singampatti area of Tirunelveli district. Pocock (1939) and Prater (1965) contain good descriptions

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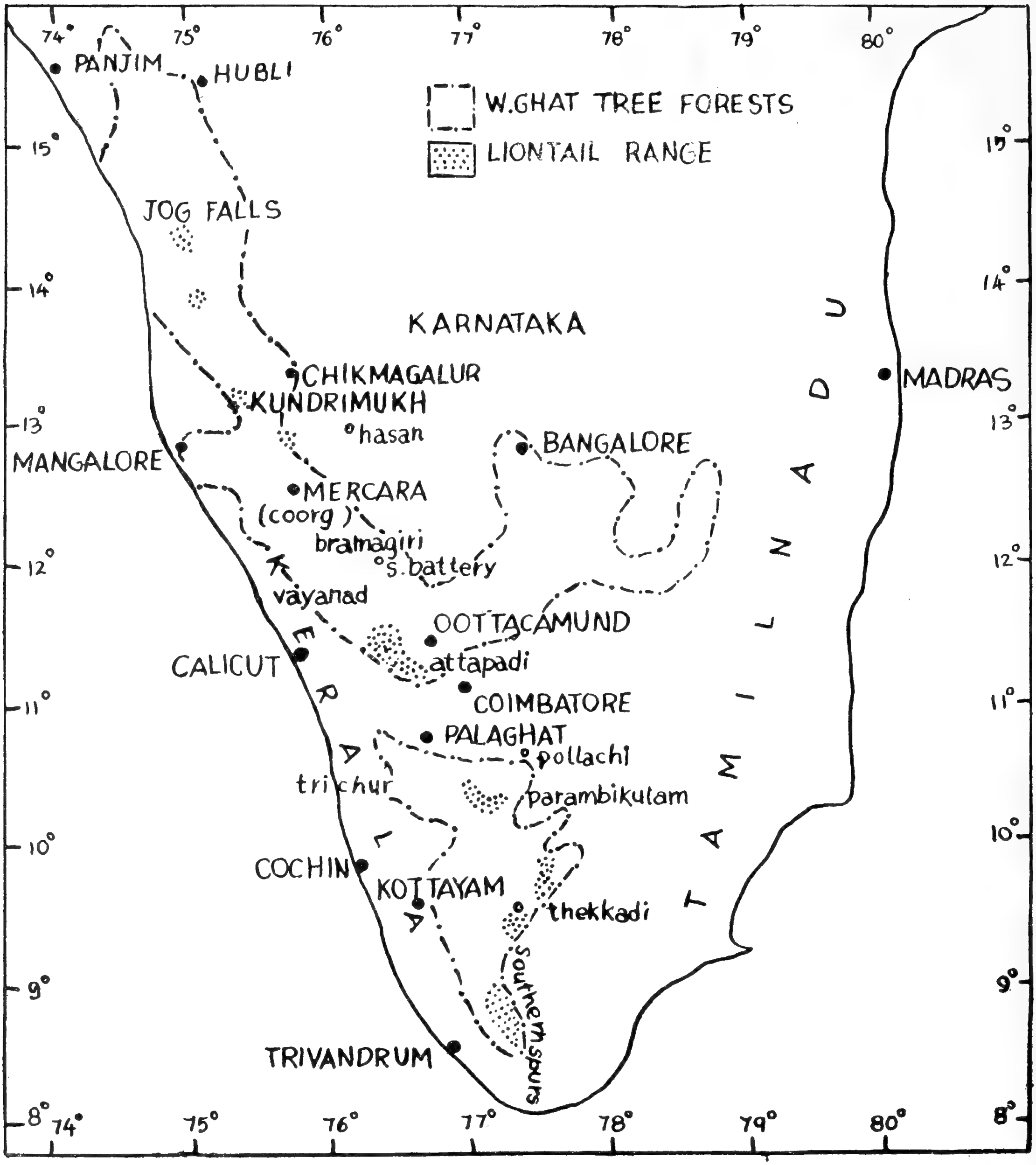

Fig. 1. Distributional range of Liontailed Macaque.

of the species and Kurup (1963) deals with the little known cranial characters.

Daniel & Kannan (1967) in a report summarise the information on the distribution of the species gained from a questionnaire and also gathered from some of the above works. Additional localities revealed by the questionnaire were Agumbe, Shimoga district (lat. 14°-13°N), Mysore; between Kudremukh and Bhagavaty, Kadur District, Sakeleshpur area, Hassan District (lat. 13°-12°N) Karnataka; 18 miles south west of Gudalur (lat. 12°-11°N) Nilgiri District, Tamilnadu; and Courtallam (lat. 9°-8°N) Tirunelveli district, Tamilnadu. In most of the reported areas, the status of the species was described as rare to uncommon except as not uncommon in Anamalai Hills in 1939-47 and in the South Tirunelveli Hills in 1947.

In view of the paucity of recent information on the status and distribution of many endangered species of wild life in the context of developmental activities and consequent biotic alterations that have taken place in the Western Ghats in recent times, a series of status cum habitat surveys of individual species and also general ecological surveys of specific areas in the Western Ghats were initiated and carried out since 1968 (Kurup 1971, 1973, 1975). In addition to considerable information—but mostly negative—collected and made available on this species as a result of this series of surveys, a status cum habitat survey specifically for the Liontails was initiated in February 1974 and after an unfortunate break finally concluded in October-November 1974. Following report, therefore incorporates the results of surveys carried out at different times during the last six years.

Appendix 1

Composition of tropical wet evergreen rainforests of Wynaad, W. Ghats (From Puri 1960 compilation)

Top Storey	Middle Storey	Lower Storey
Dichopsis, Vaterea, (specially near water courses) *Calophyllum tomentosum, Cullenia, Dysoxylum malabaricum, Artocarpus hirsuta Cedrela toona, Machilus macarantha, Mesua, Elaeocarpus tuberculatus, Bischofia, Eugenia* spp. *Canarium, Ochlandra.*	*Dichopsis, Myristica Vateria, Eugenia munronii, Actinodaphne hirsuta, Ostodes, Nephelium longana, Litsaea, Meliosma simplicifolia, Polyalthia coffeoides, Cinnamomeum zeylanicum, Elaeocarpus serratus*	*Lea sambucina Rubiaceae* spp. *Areca, Strobilanthus Psychotria* spp. *Lasianthus Pandanus, Glycosmis, Calamus Laportea crenulata*

Large fern, *Arenga* becomes conspicuous with *Mesna* and *Calamus* at lower heights. Climbers generally are not heavy though locally they may be so. No grass in undisturbed forest.

Distribution

Wynaad-Nilgiri area (12°-10°45′N)

This segment of Western Ghat lies between the border of Karnataka State with Kerala and Tamilnadu on the north and the well marked Palaghat gap on the south. The Nilgiri area

is a compact summit plateau with its highest elevation of 2,920 m at Dodabetta peak. Wynaad area lies below and west of the Nilgiris forming the bulk of the Western aspect of the W. Ghats. Most of the Nilgiris, being high table land consists of rolling downs with patches of high level wet temperate evergreen shola forests in wind sheltered mountain folds. Contiguous tropical wet evergreen shola or rain forests are confined to its submontane aspects along the border with Wynaad to the north-west and southwest of Gudalur and on its southern aspects adjacent to Attapadi hills. There are some patches of wet evergreen sholas on the leeward eastern side, but these do not have any liontail populations.

Data collected for the upper or north Wynaad forests from the Mananthavadi forests on the extreme north to Sultan battery forests bordering Nilgiri district of Tamilnadu to the north west of Gudalur make it extremely doubtful that any liontail populations survive in the Wynaad. It seems therefore, that with regard to the areas covered in the present

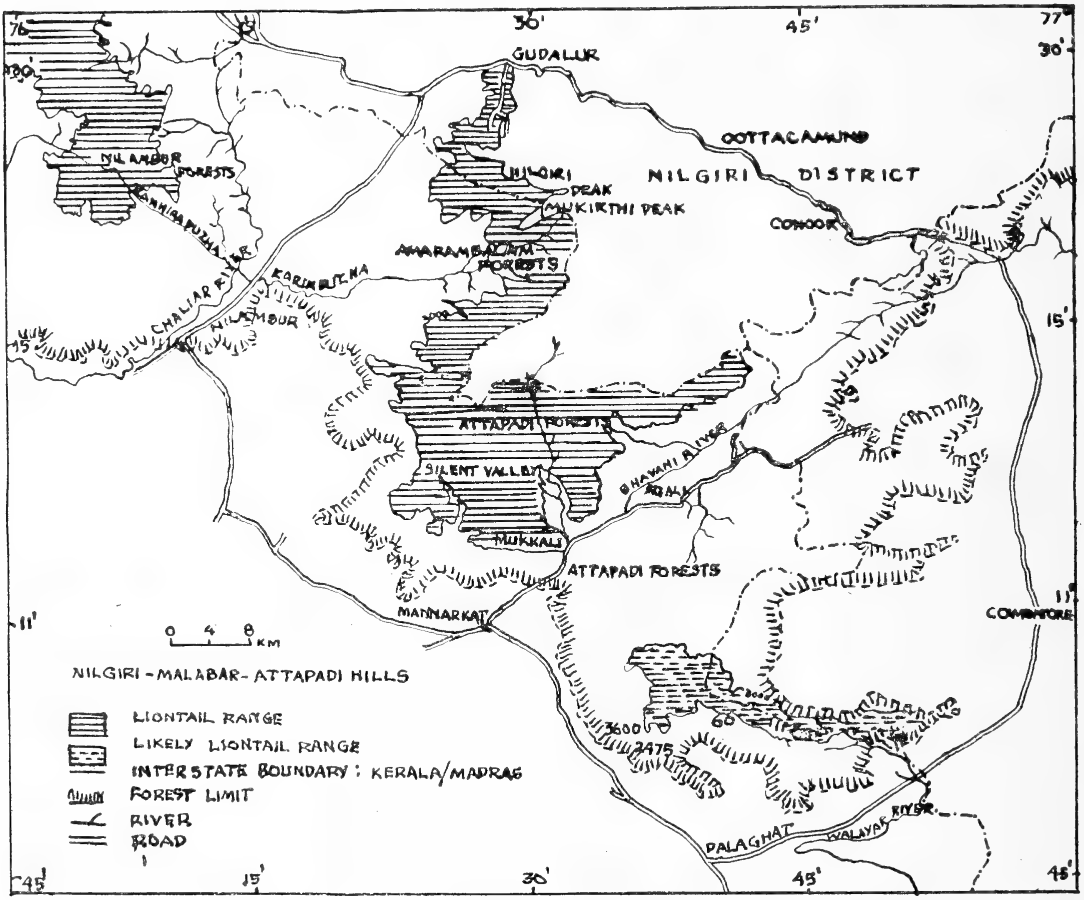

Fig. 2. Liontail habitat range, containing isolated evergreen (shola) forest in the Nilgiri-Malabar section of the Western Ghats.

surveys, the liontail range in the north commences from south of Gudalur from N. lat. 11°.30′. South of this, however, in the east Malabar region bordering the Nilgiris, there is a major habitat-range of liontails. This area stretches from the forests adjacent to the Periashola forests near Gudalur through Amarambalam reserve, covering the Silent Valley forests of eastern Malabar down to Mukkali in the Attapadi hills and then along the Bhavani river to some extend to the east along upper Attapadi hills (Fig. 2). All along this, the northern limit of the range is the precipitous escarpments of the Nilgiri massif. This range would approximately cover about 540 Sq. km. It is quite likely, however, that liontail range in this region might extend further south in the south Attapadi and upper Palaghat hills, but there is very little data available for this area. As such this is indicated separately in the map. The only other liontail range in this segment under consideration lies somewhat removed and isolated in the Nilambur forests situated to the north west of the above area. Troops were located by actual surveys or reliable reports, in the forest along Bhavani river, around Mukkali in Attapadi, in Silent Valley reserve and along the upper reaches of Karim puzha (river) in Amarambalam and Kanhira puzha (river) in the Nilambur forests. Nilambur range covers only about 185 Sq. km. but available data indicate that liontails are proportionally more numerous here.

Anamalai-Cardamom Ranges (10°.30′-9°27′N)

Anamalai segment lies south of Palaghat gap between approximately N. lat. 10°.30′ and 10° covering parts of Coimbatore district of Tamil Nadu and Idikki district of Kerala State. These ridges are divisible into higher and lower ranges. Average elevation of lower ranges is around 700 m with peaks and ridges covered by luxurient forests rising to 1,300 to 1,800 m. The higher ranges lying more westward consist of extensive open grassy hills and valleys with high level shola forests similar to those of Nilgiris and varying from *c.* 2,000 to 2,900 m in elevation. Tropical wet evergreen forest is seen between 700 to 1,600 m in elevation where the trees obtain a height of 50 m or more.

Cardamom Hills lie immediately to the south of Anamalai Hills between N. lat. 10°4′ and 9°27′ with elevations ranging from 650 to 1,300 m. From the northern Anamalais it is divided

Appendix 2

Composition of tropical wet evergreen rain-forests of Anamalais, Western Ghat. (From Puri's 1960 compilation)

Top Storey

Hopea parviflora, Messua ferrea, Vetex altissina, Agalia roxburghiana, Elaeodendron glaucum, Polyalthia fragrans, Diospyros microphylla, Eugenia gardneri, Canarium strictum, Artocarpus hirsuta, Bischofia javanica, Artocarpus integrifolia, Trewia nudiflora, Alstonia scholaris, Machillus macarantha, Filicum decipiens, Tetrameles nudiflora, Carellia lucida, Mangifera indica, Beilschmiedia bourdilloni, Pygeum wightianum, Calophyllum elatum, Salmalia malabaricum.

Middle Storey

Cyclostemon macrophyllus, Gomphandra polymorpha, Dimorphocalyx lawianus, Nephelium longana, Scolopia crenata, Diospyros bourdilloni, Acronychia laurifolia, Adenochlaena indica, Garcinia sp., *Canthium didymum, Mallotus philippensis, Flacourtia sepiaria, Sapindus laurifolius, Harpullia imbricata, Xanthoxylum rhertsa, Hydnocarpus wightianum, Actinodaphne hirsuta, Cinnamomum wightianum, Pterospemum heyneanum, Mimusops elangi, Amoora canarana, Holigarna grahaii, Prosorus indicus, Ostodes zeylanica, Myristica laurifolia, Casearia esculenta.*

Lower Storey

Strobilanthus spp., *Orphea zeylanica, Nothopegia* sp., *Saxora parviflora, Entada scandens, Calamus* app.

by the Devikolam plateau. On the south, the ranges extend as far down as the Aryankavu pass separating it from the lower southern spurs, wet evergreen forests are not as extensive as in Anamalais but are similar to those in composition. Wet evergreen forests of Anamalais are sometimes sub divided into lower evergreen, middle evergreen and upper evergreen subtypes. Liontails are mostly confined to the second type between 900 and 1700 m in elevation.

The northern and western most range of Liontails in the Anamalais is the Nelliampathy hills (Fig. 3). Since Kinloch's (1923) account of these animals in this area, coffee estates have grown in extent and the area has been opened up otherwise also by more roads and settlements. Liontail area has thus been

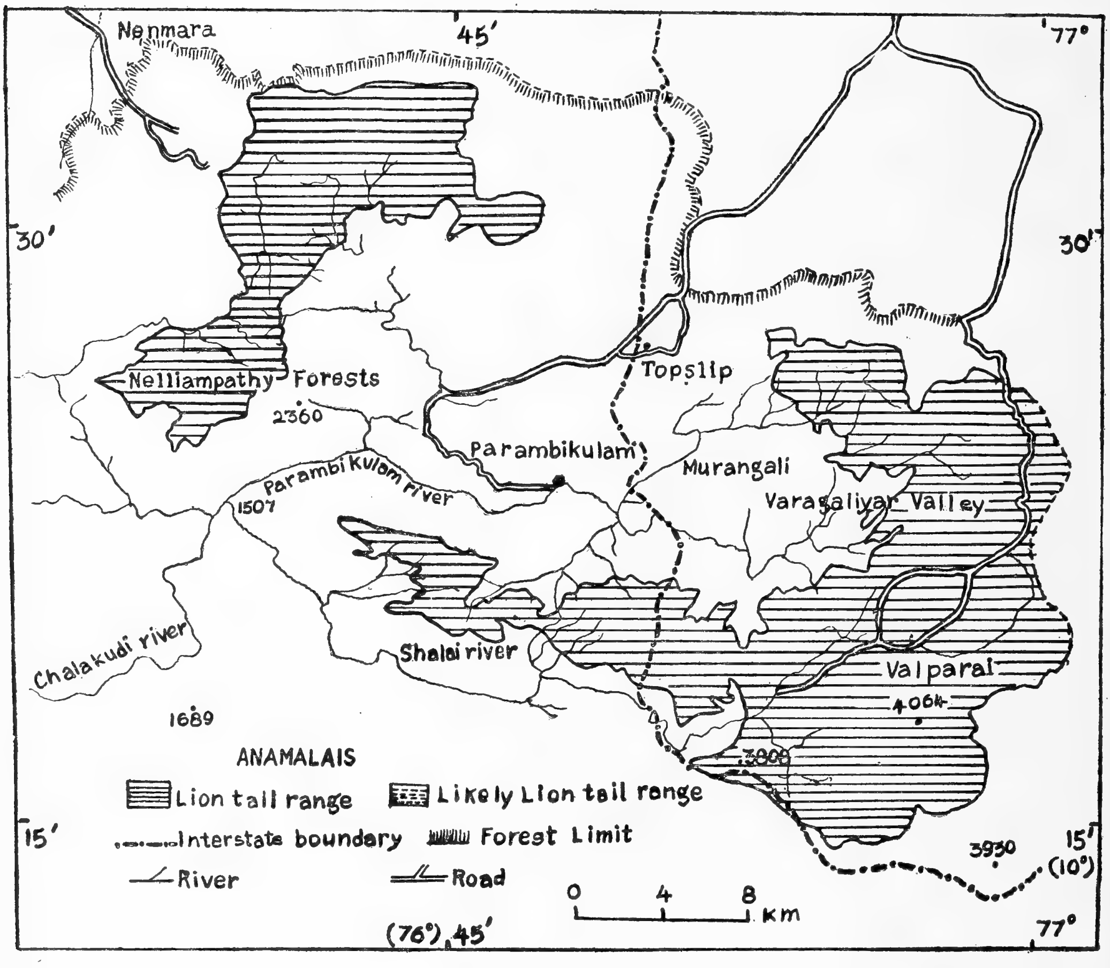

Fig. 3. Liontail habitat range, containing isolated evergreen (shola) forest in the Anamalai section of the Western Ghats.

much reduced, but small populations are reportedly existing still in the area. The range then extends south to the Parambikulam forests and then eastwards to the south of Topslip in the area of Vargaliyar and Ulandi Sholas till a little distance short of Valparai. (A local report that a troop has recently arrived and settled very near Topslip could not be verified).

Fortunately much of the range in the Anamalais falls within Anamalai and Parambikulam wild life sanctuaries which is one reason of the continued survival of the species here. Actually the troops located in the sholas within 6 km of Vargaliyar as well as the one located in the Anakunthi shola in the Ulandi block were seen on either side of the forest roads, and but for the protection afforded by the sanctuaries they would have been poached.

In the Cardamom high ranges, areas previously known to contain liontails were the Periyar wildlife sanctuary and Panniyar to the north of it. The present survey succeeded in locating another major habitat around the Kallar Valley in the Achankovil basin north of Aryankavu pass. Kanayar moozhi shola where the animals were located in the Kallar valley is about 25 km from Achankovil proper. Unfortunately extensive teak plantations are being raised in this area where the clear felling in preparation for plantation is followed for a brief two to three year period of tapioca coupes. These tapioca coupe contractors and their labourers, as for that matter contractors for any such forest operations, have often sizeable temporary settlements in the midst of otherwise undisturbed forests, and this is a major factor in decimating and driving away the wild life from their original habitats. There are extensive sholas in the Kallar Valley area and this is probably the most important liontail habitat in the Cardamom hills.

In the Periyar Sanctuary Liontails are practically limited to the Pachakanam and near by sholas below the Sabarimala plateau and then in the Malappara pakuti to the east near the border with Tamilnadu. But the road initially opened by the Sabarigiri project which runs through the Pachakanam area has, it appears driven the liontails to abandon much of their habitat in the area. The relative inaccessibility of Malappara has afforded some protection to the populations there. Similarly the Panniyar valley has also been further opened up by expanding Cardamom plantations and also due to the Panniyar hydroelectric project. Consequently liontail habitat in this area might be shrinking towards the very upper reaches of the Panniyar river.

Southern Range (9° to 8°.15′ N)

This section lies in between the Aryankavu pass near Shenkotta in the north and the Aramboli pass in the south near Nagarcoil. These ranges are much lower than other northern segmants with average height of less than 1000 m, with a few peaks between 1700-2000 m in height with the highest peak Agasthyamalai rising to 1869 m. The main sections are the Kulathupuzha hills in the north and the Agasthya and Mahendra ranges to the south. Unlike other areas, these ranges receive, in addition to the full quota of southwest monsoon, substantial rainfall from the northeast monsoon also, so that the forests especially evergreen are damper almost throughout the year. For this reason wet evergreen forests are also more contiguous and extensive. This segment of the western Ghat has therefore the maximum potential to hold liontail populations.

This is the only section where the liontail habitats seem to be rather contiguous Fig. 4). It is said to have extended till recently to areas north of the present range in the Ku-

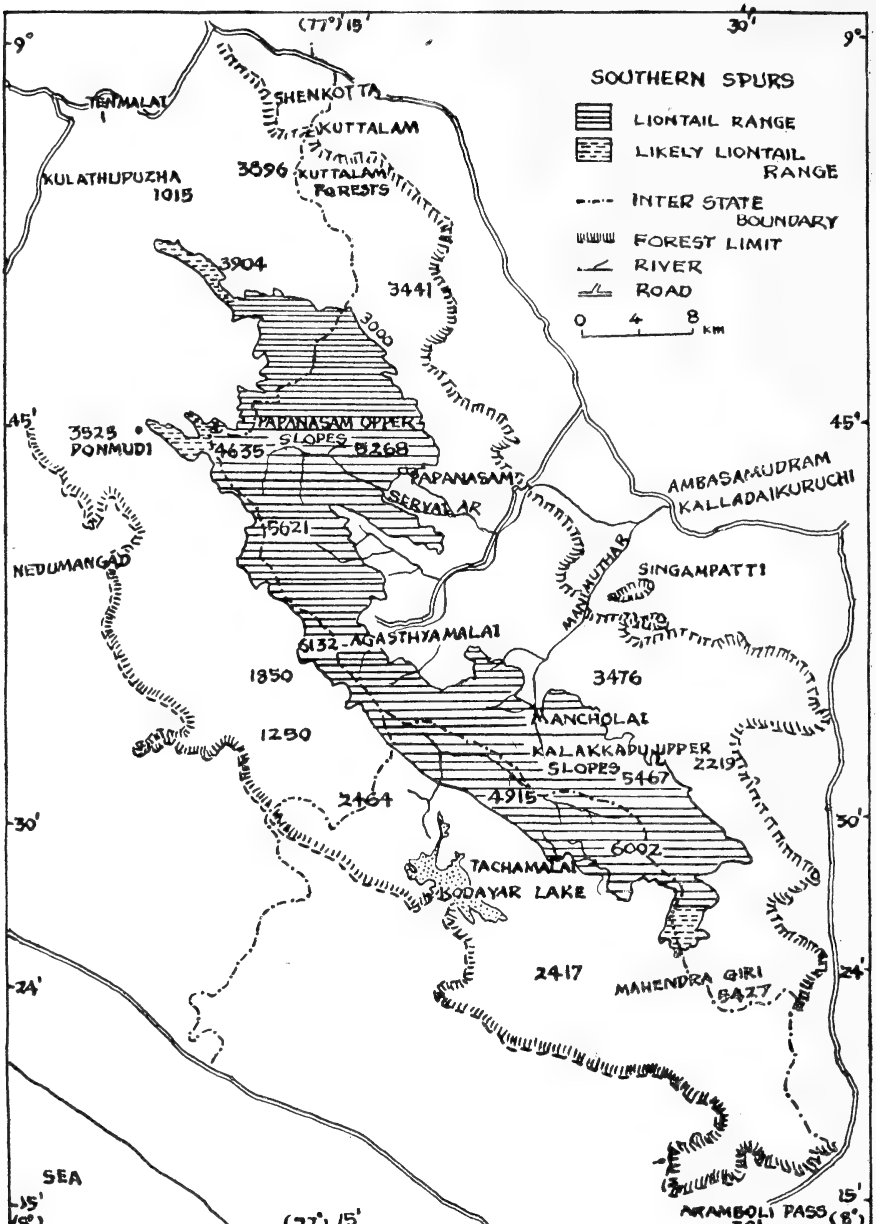

Fig. 4. Liontail habitat range, containing isolated evergreen (shola) forest in the Agasthya Ranges (Southern Spurs) in the Western Ghats.
[Height in feet—Eds.]

lathupuzha-Tenmala forests as well as in the Kuttalam forests to the east. But surveys conducted in the first area could not establish the presence of Liontails there and Krishnan (1971) mentions that they are no longer found in the Kuttalam forests. Liontail populations were located or reliably reported in the Ashambu ranges from the upper Valayar and Papanasam slopes, Kakachi of Manjolai in the Singampatti forests, Narakkadu and adjacent Kalakkadu slopes and then Kodayar and Tatchamalai forests and other areas to the north and north east on the Western slopes which are contiguous with the above areas in the east. This range now must represent practically the whole of its area in the southern most part of the liontail range in the Western Ghats.

Ecological Aspects of Liontail Habitat: Tropical Wet Evergreen Rain or Shola Forests

According to the classification of Indian forest types, by Champion & Seth (1967) the habitat of Liontails belongs to the category of tropical wet evergreen forests. These forests are known in southern India as Shola forests, but this term includes the high level wet temperate forests containing stunted evergreens found in wind sheltered folds of hills above 1700 m in elevation. These high level sholas are excluded here. Tropical wet evergreen Shola forests are characterestically developed between 500 and 2000 m elevation on the wind ward side (western) and in other areas of Western Ghats where, the annual rainfall ranges from 250-500 cm. The general climate is ordinarily within the limits defined for the low level rain forest climate, with a mean rainfall for the driest month not less than 60 cm and mean temperature of coldest month above 18°C. Relative humidity throughout the night is said to be at or near saturation, falling to 65% during dry daylight hours. Most of the general features of the low level rain forests described by Richards (1952) holds good also for the Sholas of Western Ghats. These sholas are three storied forests of very tall trees, emergents often above 40 m in height, overwhelming vegetation being woody, extremely rich in variety of species without any gregarious stand of single dominant species. Trunks often develop buttresses and cauliflory. Foliage being generally leathery dark green, mesophyll size (2025 to 18225 sq mm leaf area) and large and strikingly coloured flowers being uncommon, the overall impression is one of sombreness

Appendix 3

Composition of tropical wet evergreen rain-forest of Southern Spurs, Western Ghat (Puri 1960 compilation)

Top Storey

Hopea parviflora, Balanocarpus utilis, Artocarpus hirsuta, Gordonia obtusa, Salmalia malabaricum, Elaeocarpus oblongatus, E. tuberculatus, Pterocarpus marsupium, Ormoria travancorica, Hardwickia binata, Pithecolobium subcoriaceum, Myristica attenuata, M. laurifolia, Tectona grandis, Litsaea sebifera, Villebrunea integrifolia.

Middle Storey

Garcinia spp., *Semecarpus* spp., *Baccaurea courtallensis, Eugenia* spp., *Hydnocarpus wightianum.*

Lower Storey

Shrubs and herbs of a rich number of species of *Leguminosae, Rubiaceae, Acanthaceae, Compositae, Gramineae, Scitamineae* and *Companulaceae.*

Ferns and selaginellas abundant in moist hollows. *Balanophora indica* invariably present near the base of tall trees. Climbers and twiners include *Mucuna atropurpurea, Derris scandens, Piper niligerianum, Hoya pauciflora, Jasminum* spp., *Thunbergia fragrans, Dunbaria ferruginea, Rubia cordifolia, Dioscorea pentaphylla* and *D. spicata.*

APPENDIX 4

COMMUNITIES OF TROPICAL EVERGREEN RAINFORESTS OF W. GHATS. ADAPTED FROM PURI (1960) COMPILATION

Altitude (in feet)	Soil conditions	Rainfall	Communities	Vegetation and characteristics
1. (i) 2,500	Deep, well drained	Heavy	*Cullenia-Palaquium*	Best growth of *Mesua* and *Palaquium* community, regeneration gregarious.
(ii) 3,750-5000			*Cullenia-Palaquium-Mesua*	Not so good growth of *Cullenia-Palaquium*.
2. 3000-3750	Slightly dried low lying area	Less rain than in 1 (i)	*Palaquium-Mesua*	Co-dominants *Callophyllum elatum, Heritiera papilio* and *Artocarpus integrifolia.* Regeneration of mesua absent. At about 3,700 ft. *Palaquium* tends to disappear.
3. 3000-4000	Very damp soil, tending to be marshy	Heaviest rainfall	*Poeciloneuron-Palaquium*	Co-dominants are *Callophyllum elatum, Mesua ferrea, Cullenia, Heritura, Vateria macrocarpa.* Regeneration in *Poeciloneuron* and *Calophyllum* abundant.
4. 3,500-4,500	Marshy	Heavy	*Mesua-Calophyllum*	Associates are *Litsea* spp., *Gordonia obtusa, Elaeocarpus munroii, Cinnamomum* spp., *Symplocos spicata, Alscodaphna* spp., *Actinodaphne* spp.
(i) ,,	Moist and Well drained	Heavy	*Vateria-Cullenia*	*V. macrocarpa,* Consociation common. Co-dominants are *Cullenia excelsia, Pallaquium elipticum, Mesua ferrea, Calophyllum elatum, Polyalthia coffeoides.*
5. 4000	Near streams and moist slopes		*Vateria-Mesua*	*V. macrocarpa* of low growth, but dominant and gregarious. Subordinates are those of *Mesua—Calophyllum* association. Undergrowth *Strobilanthus. Vateria* regeneration prolific.

APPENDIX 5

PHENOLOGICAL SUCCESSION CYCLE IN TROPICAL WET EVERGREEN RAINFORESTS OF W. GHATS.
DATA SUPPLIED BY BOTANICAL SURVEY OF INDIA, COIMBATORE AND ALSO TAKEN FROM KADAMBI (1950)

Species	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1. *Actinodaphne hookeri*	B		F	LF	L	LR	R					B
2. *Artocarpus hirsuta*	F	F			R	R						L
3. *Artocarpus lakoocha*			FR	FR		R						
4. *Artocarpus integrifolia*	F	FR		R	R	R		R	R	F	R	LF
5. *Salmalia malabarica*	LF	LF	B	R	R							
6. *Calophyllum elatum*, *C. Wightianum*		F	F		R	R						
7. *Canarium strictum*	R	F	FR	F	R	R	FR			R	F	R
8. *Cedrela toona*	BLF	BF		R	R							L
9. *Cinnamomum* spp.		F	B	B	R	R						
10. *Dichopsis elliptica*	F	F	L	B	R							
11. *Dipterocarpus indicus*	F		L	B	BR							F
12. *Disoxylum malabaricum*		LF	LF	B	B	R	R					
13. *Diospyros microphylla*, *D. ebenum*	F	F	FR	FR	R	R	R	R		F		
14. *Elaeocarpus* spp. (*glandulosus*, *munroii*)	LFR	BF	BFR	R	R	FR	FR	F	FR	F	F	LF
15. *Eugenia* spp.	F	F			R	R						
16. *Gordonia obtusa*		F	FR	F	FR	FR	FR	FR	F	R	R	FR
17. *Garcinia*			F			R	R					
18. *Holigarna* spp.	F			R	R							L
19. *Hopea* spp.	F	F			R							
20. *Kingiodendron pinnatum*	F	F			R	R						
21. *Largerstroemia lanceolata*			L	F	F							R
22. *Litsaea* spp.	BL	B	F			R	R					L
23. *Lophopetalum wightianum*			F			R	R					
24. *Mesua ferrea*	B	BF	FR	F	FR	R	R	R	F	F		L
25. *Myristica* spp.			F			R	R					
26. *Poeciloneuron indicum*	B	B	F	F		R	R					L
27. *Sapium insigne*		F	BF	R	R							L
28. *Sterculia guttata*	L	BF	BF									LR
29. *Schleichera trijuga*		BF	B			R						
30. *Vateria indica*			LF			R						

Species	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
31. *Vitex altissima*					F	F	FR	FR	FR	FR	FR	
32. *Agalia roxburghiana*		F	F	R	F		R		FR	FR	F	
33. *Elaeodendron glaucum*		FR	FR	F	F	FR	FR	FR	FR	FR	F	
34. *Polyalthia fragrans*		R	R							F	F	F
35. *Bischofia javanica*	F	FR	F	FR		R	R	FR	R	R	R	F
36. *Alstonia scholaris*	FR	F								FR	FR	FR
37. *Symplocos laurina*	F	F	FR	R	FR	FR	FR	FR	F	FR	FR	F
38. *Vernonia monosis*	FR	F	FR	FR	F	F	F					
39. *Meliosma microcarpa*	FR	F	F	F	FR	F	FR				FR	
40. *Ligustrum roxburghii*	R			F	FR		FR	F	F		R	F
41. *Apodytes beddomei*			F	F	F		F	R		R		
42. *Olea dioica*	F	FR	FR	FR	FR	F	F	F	F	FR	F	R
43. *Pallaquium ellipticum*		F	F	FR	R				R		R	
44. *Goniothalamus wightii*			FR		F		F		F		R	
45. *Jambosa munronii*		F		F	R					R		
46. *Premna coriacea*				FR	FR							
47. *Pavetta hispudula*			F	F	F		F		R	R		R
48. *Psychotria anamallayana*			FR			FR	R			R		
49. *Ardisia solanacea*	F	FR		FR	FR	FR	R	FR	R	R	R	
50. *Antidesma menasu*		R	FR	FR	FR	R	FR	R	FR	R		FR
51. Phanerogamic epiphytes	LF	LF	L		R	R			B	B	B	B

B: Bud; L: Leaf; F: Flower; R: Fruit.

and monotony heightened by the absence of marked seasonal changes. Plant growth and reproduction are continuing processes through the year. Only colour relief is afforded by the frequently red or crimson of the newly sprouting leaves which have anthocyanine pigment in the cell sap instead of chlorophyll.

Composition of communities in rainforests of W. Ghats is locally variable on account of edaphic, altitudinal and micro climatical factors. Variants of major communities and their associations in the W. Ghats as also the phenological succession in the rainforests are shown in Appendices 4 and 5.

From the phenological succession data given in appendix 5, it appears that the optional periods of successions are leaf fall during Dec.-January, leaf bud opening in January-February, flowering during February-March and fruiting during May-June. But intraspecific and spatial specific variation in phenological periods must be considerable which are little studied in the Western Ghat rainforests. While the boundary between rainforests and deciduous forests in the plains is mostly climatic in nature (Richards 1952), Champion (1967) considers, the evergreen forests in the Ghats as truly climax, and deciduous forests as degraded due to biotic interference which change to evergreen climax through semi evergreen communities when the interference is excluded. Semi evergreen and even semi deciduous occurring adjoining to evergreen are similarly biotic and sometimes bioedaphic. But these types rarely progress to the original climax even when biotic factors are eleminated. According to Champion wet evergreen forest in virgin condition presents a great contrast to those that have been slightly opened, specially in the vegetation of hollows, windswept ridges, and hill tops.

Population

The inescapable conclusion from these surveys is that the liontail distribution is distributed in extremely localised, widely discontinuous patches which hold only very sparse populations in each. Almost all the habitat range surveyed are extremely underoccupied. In fact not more than two troops could be located in any one particular area during an average period of one week in each area. In contrast the frequency of sighting Nilgiri langur troops was almost six to one compared to that of Liontail. Of course, here one fact to be considered is the extent of the home range, but according to Sugiyama the troops had only 2 km^2 home range area which overlapped. But information gathered on some aspects of their habits would indicate that home range is dependent on seasonality of preferred food sources and that Liontail troops might cover considerable extent of area to visit fruiting trees. It is also possible that troops in foraging exploration might settle in new territories. Unlike in Nilgiri Langurs, this aspect of Liontail ranging make the work of locating and censusing them more difficult.

This, especially the mode of progress during daily foraging as also the extent of its terrestrial or arboreal propensity seem to be vary according to the nature of habitat. According to Hutton (1949) "they much prefer to reach out and slowly walk into the next tree or else they descend to the ground and climb up" and "never jump from one tree to another unless disturbed." Webb-Peploe (1947) also mentions their habit of "climbing slowly down one tree and walking along the ground to the next" and repeating the process in "their usual deliberate way." Daniel & Kannan (1967) cite a report of twice seeing a troop in grassland

some distance away from the trees and on being disturbed retreating to a timbered ravine and settling down in the bushes. Sugiyama (1968) states however, that although he observed signs of their spending some time on the ground, troops he observed almost always proceeded along the trees. Karr (1973) again, mentions their disinclination to leaping among and between trees even while fleeing but did not observe ground contacts. However, troops

TABLE 1

POPULATION STATUS OF *M. silenus* (HABITAT SURVEY ESTIMATE)

*Habitat	Area Sq. km.	Number of troops			Remarks
		previously known	presently known	Estimated	
Latitude 11°30′-11°N :					
Nilgiri, Amarambalam Silent Valley, Attapadi Hills	540	inexact	4	10	previously known only from Nilgiris
Nilambur Hills	185	nil	1	4	
Latitude 11°-10°N :					
Palaghat Hills	80	nil	nil	2	
Anamalais :					
Nelliampathy hills	110	1	1	3	
Parambikulam-Varagaliyar	290	inexact	3	6	
Latitude 10°-9°N :					
Cardamom Hills :					
Panniyar	270	2	2	5	
Periyar Sanctuary to Kollar Valley	535	inexact	5	10	previously known only from Periyar Sanctuary
Latitude 9°-8°24″ N :					
Southern-Spurs :					
Kuluthupuzha-Agasthya ranges	500	2	2	10	
Total	2510	5	18	50	x 15 (mean troop strength) = 750 individuals.
Latitude 15°-11°30′ N :					
Northern Wynaad and areas in Karnataka State	*Ca* 300	*Ca* 3	3	5	Areas not included in the present survey
Total	2810	8	21	55	x 15 (mean troop strength) = 825 individuals.

* Denotes general area containing disjointed sholas.

observed during two days at Varagaliyar in the present survey never descended to the ground which here was somewhat cleared due to forestry operations. But when disturbed, the entire troop bolted along the trees which included much leaping, ascending to the top most tree layer, but subsequently the sub adults, descended to the middle layer. It appears that while in the primary evergreen forests relatively undisturbed and with abundant third level vegetational cover the liontails descend down to the ground while in disturbed habitats like cardamom plantations where the lower storey canopy and the undergrowth have been cleared, they are mostly arboreal.

No attempt at censusing the population in any of their range was made. This must necessarily await further work. However, the following estimate is offered based on the experience of these surveys. (Table 1).

It is thus estimated that in their main distributional range below N. lat. 11°30′ covered during the present surveys there is approximately 2500 sq km of Liontail region containing about 50 troops and assuming an average troop strength of 15 members, the population of liontails would number about 750 individuals. Assuming another 300 sq km of liontail region holding about 5 troops in Karnataka State not covered in these surveys the total liontail population would be about 55 troops of about 825 or say 800 individuals.

Conservation Problems

The basic and primary problem confronting liontail survival in W. Ghats is the habitat conversion and eventual destruction. Here the most serious factor is the conversion of primary shola or rainforest into Cardamom plantations on a very wide scale and also for turmeric cultivation on a restricted scale. In the conversion process, the undergrowth and to some extent the third level canopy are destroyed. Of the labour force employed, some remain behind as permanent employees and the general human foraging into the vicinity is increased. Soon there is competition for some of the food sources of the liontails, like mango, guava and other fruits. A certain amount of damage to the Cardamom shoots from the monkey is inevitable as it forms its occasional food and soon the population is decimated or driven away. Even if some protection is afforded to the monkeys, these habitats are used only as secondary ranging habitat from the adjoining primary evergreen forests. If all the Sholas in the area are converted or disturbed, the population simply disappears from the area.

By the very nature of the liontail habitat, its restriction to evergreen rainforests, the distribution of the liontails has to be patchy, as even in contiguous areas of favourable climate and edaphic factors, biotic interference has destroyed the continuity of evergreen forests. Rainforests being climax formations where rate of growth is very slow, once altered or destroyed, take very long to be restored. Much of the grassland and rolling downs in the higher zones of W. Ghats are but the end products of destroyed high level evergreen forests.

A second factor is the direct decimation by poachers, forest coupe contractors and the like. There is strong local belief in the aphrodisiac and medicinal property of the black monkey and although this mainly pertains to the other black monkey of these jungles, the Nilgiri Langur, the two are easily mixed up in ignorance and for many both will equally do. However, in most of the localities it was found that the tribals and others in intimate contact with forests readily distinguish the two, and the liontail is referred to very aptly as *Sinkalan* (Leonine) with some reverence and

the Nilgiri langur as *Karimanthy* (black monkey) or simply *manthy*. Capturing for live sale in animal markets of big cities is also considerable as the liontail is quite a striking animal with beautiful fur. Often the young one is caught after killing the mother. On the whole, direct decimation is a factor for immediate remedial action.

Conservation Measures and Recommendations

Conservation of liontail habitat does not pose any serious problems. Preservation of climatic climax community is inherently in the interest of good forestry management. One of the factors little realized is the importance of the ecological role of the evergreen shola forests in the Western Ghats. Most of these forests especially those in mountain folds and valleys contain several water courses at the bottom which contribute significantly to the drainage of the area. In summer, such water courses would be the only source of water available to the Wildlife and the shola forests affording the only effective cover for many of these species. Destruction of these forests would naturally result in soil erosion and consequent silting up of these water channels, conversion of biota and disappearance of many species of wild life from the area.

Evergreen forests of the Western Ghats are commercially not very remunerative. Among the multiplicity of species, only few are of any economic utility and these forests are generally worked under the selection system where minimum exploitable size of usable trees are felled on their rate of growth and feasible felling cycle. As the rate of tree growth of evergreens is slow, felling cycles are long. On the whole total economical yield including that of minor forest produce (products other than wood) is relatively unimportant. It will not be therefore, difficult to stop any type of extracting and cropping operations in these forests. As such the only serious threat to these forests is from the expanding Cardamom and turmeric plantations.

Legally liontail is a protected animal. Its killing or capturing and export are banned. But poaching, while restricted in the habitats falling under wild life sanctuaries, continues unabatedly in other areas. This is an aspect which can be remedied immediately by more stringent statutory and implementation procedures.

Recommendations:

Considering all factors, the following measures are recommended for immediate action:

1. (a) Wet evergreen rainforests of the Western Ghats form only a very narrow band mostly along the Western aspect and this is at present much fragmented. This, being the original climax formation of the W. Ghat, should be declared inviolable and preserved eliminating all disturbing forestry operations and preventing all further encroachments of plantations and the like.

   (b) Later, a well thought out plan may be drawn up to restore the continuity of the evergreen belt, through probably allowing the adjoining deciduous strips to naturally progress towards evergreen climax, and if necessary by afforestation.
2. When new forest or public roads are built in the area, care should be taken not to cut across any major shola forest but as far as possible circumvent the same.
3. A concerted publicity drive may be launch- to educate the public regarding the rarity and need of conserving the liontail, baselessness of the belief of any medicinal property of its flesh etc. Suitable hoardings could be erected at strategic areas in its

habitat depicting the animal and exhorting the people to assure its survival.

4. Forest authorities will have some information on the animal poachers and dealers in their locality. A closer watch should be maintained of their premises, for live animal traffic. Similarly wild life Inspectorate or Forest authorities should periodically inspect the animal dealers' facilities in the big cities.
5. Major liontail habitats (as per the figures provided) which are outside wildlife sanctuaries, may be declared as liontail reserves and the regulatory system of check posts, road bars etc. may be installed at the approach and exit areas with necessary staff.
6. As a more long term measure, a project for a two to three year comparative study of the conservational aspects of the ecology of liontails may be initiated with a view to propose long term measures not only to conserve the species but also to augment its populations and habitat range.

Acknowledgement

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APPENDIX ADDED IN PROOF

Fodden (1975) has listed liontail localities culled from literature. Green and Minkowski (1978) have also given those reported during last fifty years. Below is given an up-to-date gazetteer of all known liontail localities, containing also information obtained from recent surveys conducted between 1975 (when the manuscript of the present paper was prepared) and May 1978. This summarises the present state of our knowledge of liontail distribution and status.

GAZETTEER OF KNOWN LIONTAIL LOCALITIES WITH PRESENT STATUS

Localities	Area Around Lat. N	Area Around Long. E	Altitude m	Source	Status
Near "Goa District"	15°16′	74°00′	300 ?	Baker, H. in Blyth (1859)	A
Anshighat	14°56′	74°22′	300	Daniel & Kannan (1967)	D
Jog Falls	14°16′	74°43′	500	,,	P
South Kanara, North border	13°55′	74°40′		Shortridge, C. in Ryley (1913)	L
Agumbe ghat, Someshwar	13°15′	74°55′	600	Daniel & Kannan (1967)	P
Kundremukh – Bhagavati	13°14′	75°18′	900	,,	P
Sakaleshpur, Hassan	12°42′	75°51′	900	,,	D
Coorg, W. Border	12°30′	75°30′	900	Shortridge, C. in Ryley (113)	D
South Wynaad	11°39′	76°00′		Kurup, G. U.	P
Kuttiyadi pass	11°39′	75°45′		Jerdon (1867)	D
Vayithiri forests			700	Kurup, G. U.	L
Vellarimala			800	Kurup, G. U.	P
Nilgiri:					
Gudalur ghats	11°25′	76°28′		Kurup, G. U.	P
Amarambalam—Silent valley—Upper Bhavani valley	11°22′	76°28′	1000	Kurup, G. U. also Green & Minkowski (1977)	P
Palghat Forests	10°50′	76°45′	900	Kurup, G. U.	L
Anamalai					
Nelliampathy forests	10°26′	76°31′	1000		P
Palagapandy	10°36′	76°45′		Kinloch, A. M. (BNHS) 1920	
Seethagundy					
Kollengode forests				Lindsay (1926)	
Cottangadi				O'Brien, F.R.O. 1921 (BM)	
Anamalai Wild Life Sanctuary	10°27′	70°36′	700	Kurup, G. U.; also Green & Minkowski (1977)	P
Karianshola	10°20′	77°05′	1200		
Anakunthy shola					
Varagaliyar shola					
Manamboli shola					
Water falls (near Valparai)				Padmanabhan, S. (Personal)	
Grass hills shola			1300	Davidar, E.R.C. (1971)	
Parambikulam Wildlife Sanctuary:	10°20′	76°45′	570	Kurup, G. U.	P
Vengolimala shola			570	Kurup, G. U.	
Kuriarkutty				Biddulph (1953) (BM)	

Localities	Area Around Lat. N	Long. E	Altitude m	Source	Status
Chalakudi—Sholayar river basin	10°20′	76°45′	900		P
Between Upper and lower				Kurup, G. U.	
Sholayar dams Vazhachal				Oates, J. F.	
Munnar				Kurup, G. U.	P
Kadalar estate	10°05′	77°03′	1350		
Karadipara, Pallivasal	10°02′	77°02′			
Kallar, Pallivasal					
Cardamom Ranges:					
Panniyar	9°59′	77°13′	900	Sugiyama (1968)	P
Erachippara				Kurup, G. U.	
Santhampara	9°57′	77°11′	900	Kurup, G. U.	P
Moolathara				Kurup, G. U.	P
Peythotti				Kurup, G. U.	P
Mathivettankuzhi				Kurup, G. U.	P
Periyar Sanctuary	9°33′	77°06′	900	Kurup, G. U. also Green &	
Pachakanam	9°27′	77°20′		Minkowski (1977)	P
Uppupara					
Vallakadavu					
Pulladi Estate					
Malappara					
Moolakallu					
Kallar Valley	9°10′	77°15′	900	Kurup, G. U.	P
Varushanad Valley	9°35′	77°35′	900	Hutton, A. F. (1949)	D
(High Wavy mountains)					
Bhagavathipuram—	9°01′	77°11′	500	Oates, J. F.	P
puliyara (Shenkotta)			650	Kurup, G. U.	
Agasthya Ranges					
Kuttalam	8°45′	77°10′		Krishnan, M. (1972)	A
Mundanthurai Sanctuary					
Walayar	8°38′	77°17′	900	Kurup, G. U. also Green and	P
Kannikkatti				Minkowski (1977)	
Kanthappara Estate					
Kattalamalai					
Kalakkadu Sanctuary	8°34′	77°12′	900	Daniel, J. C. (1970)	P
Kakkachi to Chengaltheri	8°24′	77°28′	1300	Green and Minkowski (1977),	
Manjolai				Kurup, G. U.,	
Singampatti				Karr, J. R. (1973)	
Upper Kodayar					
Mahendragiri					
Narakkad					

A—Absent, P—Present, L—Likely, D—Doubtful

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THE DOUBTFUL FUTURE OF THE PIGMY HOG AND THE HISPID HARE[1]

Part I—A Conservation Report
Pigmy Hog Field Survey, 1977

William L. R. Oliver[2]

(*With a plate and three text-figures*)

Introduction

Following the dramatic reappearance of the pigmy hog *Sus salvanius* and the hispid hare *Caprolagus hispidus* in March 1971, much interest has been generated in these species. The events leading up to their rediscovery and the subsequent history of the captive animals has been well documented elsewhere (Mallinson 1971; Tessier-Yandell 1971) and it is unnecessary to review it here. The seemingly unlikely close association of the two species is both interesting and pertinent, though the reasons for it are not hard to find since they apparently show a similar distribution and habitat preference, i.e. the 'thatchlands' of north-western Assam. They were both unjustifiably considered extinct by some authorities on the purely negative evidence that stemmed from a common lack of knowledge owing to poor feedback from local sources of information. However, their apparent scarcity is not merely a function of the remoteness of their distribution. The fact that their distribution is limited has been appreciated, as has their scarcity even within the narrow confines of this distribution range and both species deservedly merit Schedule I categorisation in the Indian Wild Life Protection Act (1972). This known scarcity has been attributed to the limited distribution and to habitat destruction though the real species situation and its underlying causative factors have been poorly understood. Hence the 'indeterminate' Category 4 status accorded to both species at the present time by I.U.C.N. Red Data Book.[3]

There are actually relatively few documented accounts of either pigmy hog or hispid hare in the intervening period between the 1971 reappearance and their original published descriptions in the mid-19th century. This lack of data is not altogether surprising in view of their small size and secretive nature, their dense and observationally-unsuitable habitat and their (scientifically) remote distribution. What little knowledge we have is therefore based primarily 'shikar' accounts but would indicate both species always had a somewhat restricted distribution within recent historical times. Thus over the last century or so, hispid hare had been recorded at intervals along the Southern Himalayan foothill belt that stretches from northern Uttar Pradesh in the West, through Nepal, Sikkim, North Bengal, southern Bhutan to north-western Assam. As far as we know pigmy hog had a similar dis-

[1] Accepted August 1977.

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[3] As a result of the findings of this report the I.U.C.N. Red Data Book categorisation for this species has now been changed from Category 4 (indeterminate) to Category 1 (endangered).

tribution though there are no accounts available for the species as far west as Uttar Pradesh. Within the last few decades both species have been declining steadily and all post-1971 records (with one exception) appertain to north-western Assam, though the distribution of both species may stretch into east North Bengal and southern Bhutan where the thatch-scrub jungle continues into these areas. (Fig. 1).

maputra river before or in Arunachal Pradesh or north-western Assam. Both latter districts are high rainfall areas with a preponderance of evergreen forest and little thatchland in the forest belt.

In the interim the present-day known distribution of both species is exclusively the forest belt of north-western Assam. It is quite likely therefore that both species are now unique to this vicinity and anyway should be

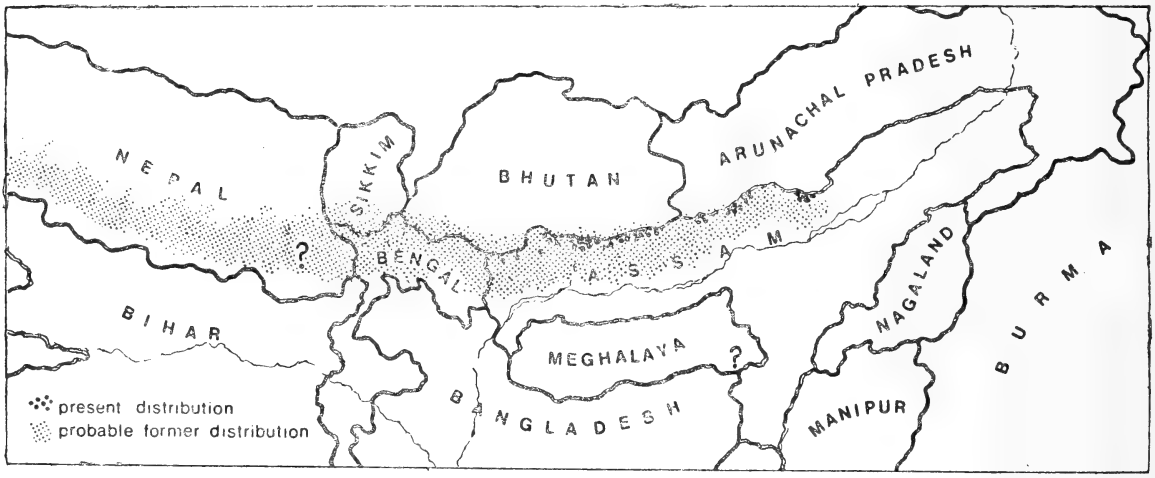


Fig. 1. Present and Former distribution of Pigmy **Hog** (*Sus salvanius*).

regarded as such until reports from other areas are positively confirmed or negated. By the very nature of the habitat and of the species it is not possible to be categorical about distribution, but even if other populations do materialise, it is very likely that the population/habitat pressures that are so strongly evident in Assam (but which are not unique to this area) would apply equally strongly elsewhere.

Eye witness accounts support this steady decline with reports of observations over a much larger area of Assam 15 years ago or more. In 1964 a U.S. expedition from the Hormel Institute spent four weeks looking unsuccessfully for pigmy hog in Nepal. A recent and apparently reliable report of pigmy hog in Cachar in south-eastern Meghalaya (G. S. Chaudhury, pers. comm.) is most interesting for it implies a much extended former distribution for this species owing to the necessity for circumnavigation of the Brahmaputra river barrier to the south. However, neither species has been reliably recorded south of the Brah-

The story is a familiar one, for which progressive human settlement is largely responsible by making further and yet further inroads into former natural habitat. Whilst

some may feel this is deplorable, it is of course objectively irreversible and practical conservation measures must be directed at the protection and salvage of the small remaining habitat areas. As far as pigmy hog and hispid hare are concerned, the situation is immeasurably worsened by the degradation of the small remaining thatch-scrub areas for the exploitation of forest resources and the tradition of burning during the dry season.

Since 1971, there has been considerable expense and effort engendered in efforts towards their conservation, particularly of pigmy hog. However, this effort has been primarily directed towards the acquisition of specimens for captive husbandry and no action has been taken towards the underlying causative factors in the decline of the wild populations. That the wild populations are declining is in no doubt as the known distribution and remaining habitat dwindles and becomes increasingly discontinuous and increasingly under pressure.

Moreover, the captive breeding projects for these species have not been an unqualified success. Hispid hare are probably 'non-starters' in captivity anyway as the few specimens that have been caught have amply demonstrated by succumbing within remarkably short time after capture. Hares are notoriously difficult to maintain in captivity owing to their temperament and disease-susceptibility, and considerable expertise is required even to maintain them without breeding. By contrast, the pigmy hog captive breeding effort has shown promising indications of its potential as a safeguard to the species survival, though in retrospect this potential has been far from realised. Despite an apparent ease of breeding and the successful long-term maintenance of a few individuals, mortality has remained unjustifiably high owing to crude methods of capture, the nervous disposition of the newly caught animals themselves and a lack of expertise resulting in poor husbandry practices. However, the captive stocks that remain are still potentially viable even if much depleted, and they have provided much valuable information on reproductive and behavioural biology. Perhaps equally important is that the considerable efforts that have been made with regard to captive pigmy hogs have also generated considerable public and official interest and awareness in this species and this could be of great significance to future policy regarding their conservation.

However, though captive breeding efforts are meritorius in that they are conservation-oriented, they ignore the basic and much more significant and important aspects of the species' predicament, i.e. the fundamental problems of the wild situation. Captive breeding however successful, does not represent a solution to the endangered species problem, even though it is a very valuable tool that may provide a hedge against extinction, a study source and (ideally) a source for reintroduction should that become necessary. Thus the continued efforts of research and breeding captive pigmy hogs must go hand in hand with efforts at reversing the current trends of the continuing degradation of wild habitat and wild populations. It is hoped that this study will provide some information as to the causative and fundamental problems faced by the wild stocks and provide a framework for their conservation. Problems faced by the wild populations are profound but not irreversible provided they are looked at objectively and any action that may be generated is not merely legislation on paper.

The survey in which this report is based was undertaken as a result of the realisation that an objective analysis of population trends and pressures was required before any action

was contemplated. It was also intended to investigate the biology of these species in the field and the survey was arranged to coincide with the period following the annual burning of the thatchlands where these animals were known to occur. This was to facilitate behaviour study as it is during this period that most observations of pigmy hog have occurred as the thatch grass is naturally at its shortest following burning. The survey was of admittedly short duration, i.e. March-June 1977, but in the event has proved to encompass the most critical period for the biology and conservation of these species. Finally it is necessary to add (by way of excuse) that the survey was not as fully comprehensive as would have been desirable owing to the author's movements being limited by time, by foreigner's permit requirements, poor communication facilities and for the most part, poor weather conditions. Having said that, the pattern that emerges is till startlingly apparent even though it was not possible to visit all the probable or known areas of distribution.

The Reserve Forest Belt

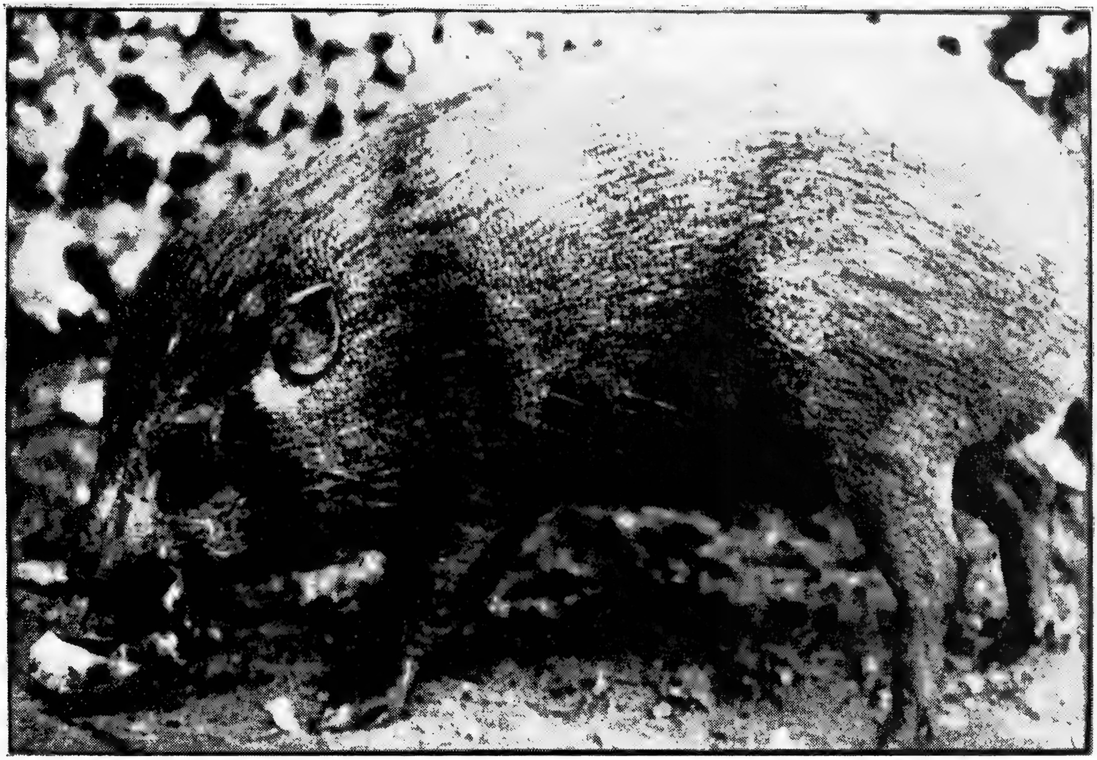
Before analysing the results obtained it is important to establish the present context with respect to the wild situation. Thus there is comparatively little 'wilderness' left in Assam owing to the continuous and progressive settlement and cultivation of an expanding and immigrating people. Land is under tremendous pressure and the rate of transformation of former habitat has been dramatic in the past few decades. This is a continuing process and human population increases have been accelerating disproportionally owing to immigration, particularly of Nepalese peoples, but also to a lesser extent some Bengali and other peoples. This process has resulted in the replacement of practically all natural habitat up to (and frequently beyond) declared forest boundaries.

The north-western forest belt, where these species occur is a semi-continuous series of forest and thatchland areas that run from east North Bengal to Upper Assam. Immediately to the north the primary forest (the so called 'bhabar' forest) continues into the foothills of Bhutan and Arunachal Pradesh. The eastern side a higher rainfall area and is comprised mainly of evergreen forest with little or no thatch-scrub jungle which accounts for the likely absence of either species to the east of North Lakhimpur.

This forest belt is intersected by tributaries of the Brahmaputra River and is divided into Reserve Forests, Unclassed State Forests and two wildlife sanctuaries (Manas and Sonai-Rupa). Neither Reserve Forests or Unclassed State Forests are regarded as wildlife areas in as much as legislation for wildlife protection is governed only by the individual species categorisation according to the Indian Wild Life Protection Act and regulations governing access to persons entering the Reserve Forests. Essentially Reserve Forests are geared towards the commercial exploitation of the forests by the Forestry Department, i.e. Reserve Forests have an afforestation or reafforestation programme. Thus primary forest is felled for timber extraction and thatchland areas are afforested with commercial species plantations.

Most of the thatchland areas are also subject to annual harvesting for thatch (thatch-mahal) under permits issued by the Forest Department as thatch is a very important building material which is used for roofing for the vast majority of dwellings in Assam. Some Reserve Forests also have grazing concessions and some have sand and stone mahals.

The Unclassed State Forests which are interspresed between the Reserve Forests, do not



(Photos: *Author*)
(Captions overleaf)

Above: Adult male pigmy hog photographed on a tea estate in Assam. This animal weighed approximately 8 kg and stood about 11 inches at the shoulder. n.b. marked streamlining for a very dense habitat. *Below*: Adult female hispid hare caught accidenly in Barnadi Reserve Forest in late April 1977, whilst trapping for pigmy hogs under permit for the attachment of radio harnesses. The animal was immediately released after being photographed. n.b. heavily pregnant.

have an afforestation programme and are not actively managed by the Forest Department, and most of them are being progressively encroached upon and many are unlikely to survive as forest areas. The degree of encroachment varies considerably from negligible at the present time to almost complete encroachment. Many Reserve Forests are also subject to encroachment to a greater or lesser degree. The majority of settlement in Unclassed State Forests and Reserve Forests is actually encroachment but there are official settlements particularly in Unclassed State Forests. In some places little or no action has been taken against illegal settlement, but elsewhere successful eviction proceedings have been instigated though sometimes with difficulty owing to the claims of squatter rights.

These processes have a particularly serious effect on the thatchland and scrub jungles which are highly susceptible to human disturbance particularly by dry-season burning. This habitat (unlike the true forests) has now become discontinuous and forms a series of discrete and highly vulnerable units within declared forest boundaries. Moreover these thatchland areas tend to be along the southern edge of the forest boundaries and are therefore often in particularly close proximity to human habitation and few of these areas too remote to be easily accessible. There are actually two classes of thatch savannah, i.e. highland and lowland savannahs. The latter is subject to heavy waterlogging or even prolonged inundation during the monsoon. In the north these areas are typically the 'char' grasslands along river boundaries which probably never support these animals. The better-drained highland savannah basically comprises typical thatch-scrub jungle (when left unburnt) which is the habitat of these species.

The Barnadi Reserve Forest

The main study area was the Barnadi Reserve Forest in the Rajagarh area of Mangaldai in Darrang District. This locality was an obvious choice as it was from this region that both species originally reappeared and has been the source of the original (and nearly all subsequent) captive stock. Together with the Manas Sanctuary it is also the only area from which these species were widely known to occur.

This area was therefore thoroughly surveyed as to distribution of the species, habitat preferences, behaviour and animal movements. The report on many of the aspects of the study are published elsewhere (Oliver 1977) and I have only touched upon behaviour where this is directly relevant to the conservation issues. For example it is very easy to prove or negate the species activity in any particular area by screening for behavioural indicators such as the distinctive forage marks of pigmy hog or the thatch cuttings/faecal deposits of hispid hare. Therefore a careful examination of the whole area together with the questioning of forest officials, local villagers and shikaris easily establishes the population distribution and habitat preference. A critical analysis of an area such as the Barnadi Reserve Forest, manifestly demonstrates the reasons for the continued decline of the wild populations.

Barnadi lies about four miles north of Attareekhat and one mile north of Rajagarh village. It is bordered in the west side by the Bornadi River and to the east by the Nalipara Nadi. The northern boundary is the common international border with Bhutan and the primary forest belt is continuous with that of the Bhutan foothills. The Bornadi river is a com-

mon boundary with the Darranga Reserve Forest to the west (where pigmy hogs have also been recorded) but to the east there is an Unclassed State Forest which is extensively cultivated by encroachment and some official settlement. All southern boundaries verge onto cultivation areas and though much of the perimeter is fenced, this fencing is in poor repair and is completely ineffective in restricting unofficial human and domestic animal movements. There is therefore free access to the reserve areas along the south-west, south and south-east boundaries. The reserve area was formerly entirely surrounded on the southern sides by mixed highgrass scrub jungle, but with progressive settlement over the last 10-15 years these areas are now purely rice-paddy cultivation and village settlements. The total reserve area is approximately 24.6 sq. kilometres of which approximately 8 sq. kilometres (20%) along most of the western side is extensively encroached. Approximately 7 sq. kilometres is mixed deciduous and evergreen forests and thus is largely undisturbed.

The central and south-western section is an extensive and continuous thatchland belt and afforestation area with plantations of simul, gomari, bonsom and some (exotic) teak and Eucalyptus. This thatchland is subject to a thatch-mahal and this thatch concession covers the entire area. The thatch is officially harvested between 1st November and 30th April by a contractor (permit holder) or private individuals with contractors permission. There are no grazing concessions, but in fact the thatch area is extensively and illegally grazed daily by about 250 head of cattle and a few domestic buffaloes and sheep. The whole thatch area is approximately 12.6 sq. kilometres (i.e. about 50% of the total Reserve Forest).

Nearly all the thatchland is burnt annually during the dry season. This burning is primarily 'accidental' by local people as opposed to 'controlled' by forest officials. The extent of burning varies year by year as it is illegal and uncontrolled, though there are some attempts at control by thatch cutting and burning 'fire-lines'. The accidental burning is essentially undertaken by 'miscreants', i.e. by carelessness (e.g. herdsmen cooking or smoking in the forest) or the deliberate firing by villagers to improve grazing and thatch yield. The uncontrolled burning in the height of the dry season (late February to early April) is more harmful to plantations than earlier controlled burning when the grass is not tinder-dry. The forest department takes on extra staff as 'firewatchers' in an attempt to control burning during this period, though burning is difficult to prevent and very difficult to control at this time, and to judge from the acreage burnt in 1977 these precautions are completely ineffective. Deliberate or accidental burning by miscreants is greatly facilitated by the ease of access to the forest by the long perimeter between the thatch area and the surrounding cultivated land, i.e. about 10 kilometres.

This burning has a catastrophic effect on the hispid hare and pigmy hog population and the fauna and flora of this thatchland ecosystem in general. There is a profound difference between the rich and diverse biological complex of the unburnt mixed high thatch-scrub biotope and the relatively simple uniformity of regrown burnt thatchland. The difference is clearly a function of the varying species susceptibility to the fire hazard and the ecological instability caused by annual burning. Fire is highly selective and generally speaking only well established trees and plants with well developed root systems are likely to survive. Firing completely destroys all ground cover (and therefore also most food supplies) in the post-burning period prior to the 'chota' (small)

rains which usually occur in April. Plants with well developed root systems and rapid vegetative growth can exploit this situation and thus burnt habitat is characterised by poor diversity but extensive and rapid growth of certain species (e.g. in Barnadi, *Saccharum spontaneum, Phragmites karka,* (both thatch species), *Eupatorium ordoratum, Lea robusta* and *Salvia* sp.) Recolonisation by other plant species naturally depends on their reproductive potential and/or seed and spore dispersal mechanisms. Similarly faunal recolonisation depends on such factors as particular species mobility (thus birds can recolonise quickly), reproductive potential and the local availability of unburnt habitat or (dubiously) alternative temporary fire-displacement habitat.

It is important to acknowledge that not all typically thatch-scrub jungle species are affected to the same degree. Animals that migrate during the dry season avoid the problems of food and water supplies and it has been argued that grazing ungulates may even benefit by dry season burning with improvement of fodder. Other species avoid the problems of dry season survival by aestivation (e.g. reptiles and some insects) or life-history cyclicity (many invertebrates) may also be less seriously affected, though this would clearly depend on the behaviour or mechanisms associated with this torpor phase. It is equally clear that species such as pigmy hog and hispid hare (which we can positively demonstrate remain resident and active in the thatch-scrub during the dry season) must be very seriously affected by burning through the loss of their habitat. It is immaterial that cover is only lost for a relatively short period (two to three months prior to regrowth of vegetation) as there is no suitable alternative habitat and anyway the habitat is seriously modified by the 'selective effects' of burning. Furthermore, it is evident (and amply demonstrated by field analysis) that thatchland areas take several years to fully recover from the effect of burning (one of the reasons for deliberate annual burning is to prevent 'good' thatchland from reverting back to mixed thatch-scrub jungle). Thus annual burning seriously modifies ecosystem composition as long as it is maintained and even a single chance fire can be reasonably expected to show its effects for at least a few years owing to the differing fire resistance of species and other factors already outlined.

The distribution patterns of hispid hare and pigmy hog in Barnadi Reserve Forest manifestly demonstrates these arguments. The burning in late February/early March 1977 was severe in its extent and approximately 80% (i.e. 10 sq. kilometres) of the thatch area was burnt. The population distribution was monitored at regular intervals between late March to early June and remained resident and constant during this period, i.e. entirely restricted to the larger areas of remaining unburnt habitat as shown in Fig. 2.

This pattern of distribution is extremely significant to the conservation of both species and from it we can extrapolate several important facts:—

(I) Both species are found only in unburnt thatch-scrub jungle at this time of year.

There is actually no other suitable habitat with dense cover available in this vicinity. Burnt thatchland offers absolutely no cover and a dearth of foodstuffs in the post-burning period. They have never been reliably recorded from primary forest except in areas immediately adjacent to unburnt habitat, i.e. foraging excursions, or consequent to forced movement of animals displaced by burning. There is actually very little ground cover in the typical primary forest of this region.

(II) Unlike many of the larger indigenous mammals, these species do not migrate but are *resident* in this type of habitat during the dry season.

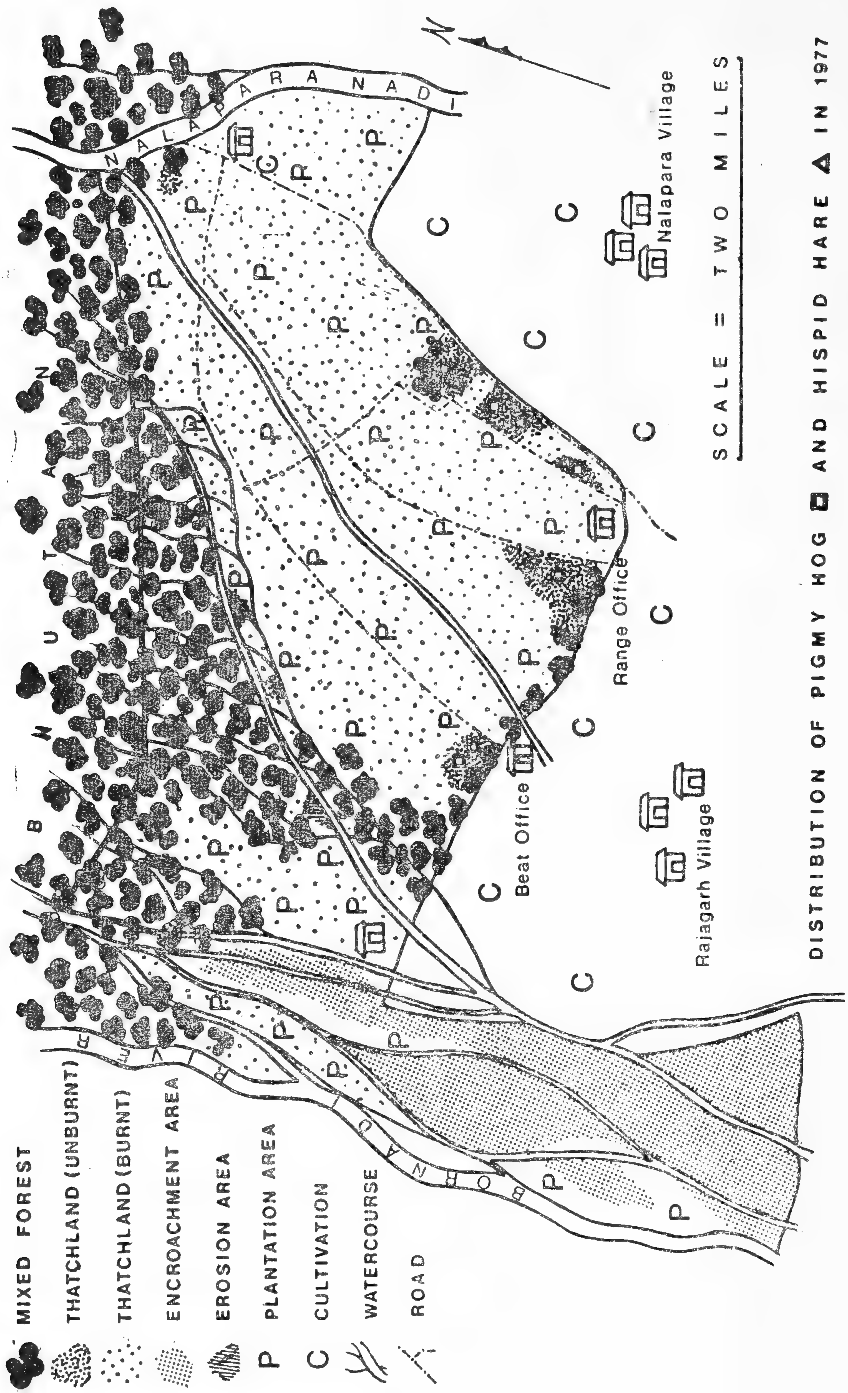


Fig. 2. The Barnadi Reserve Forest was the main study area. Distribution of pigmy hog and hispid hare in 1977.

This is evident as they are found throughout the dry season in suitable unburnt habitat. All observation of these species movements during the day season are directly consequent of displacement from their former habitat by burning, e.g. pigmy hog etc. most frequently seen (and caught) after burning when they are forced out of dense thatch into surrounding cultivation areas seeking cover. Indeed, the original captures in the Attareekhat Tea Estate in March 1971 was consequent of an extensive fire in the thatch-land in the Rajargarh area (Tessier-Yandell 1971). Similarly, pigmy hogs are observed on Budlapara Tea Estate to the south-east of Barnadi every year immediately after burning (D. K. Mukherjee, pers. comm.).

(III) Despite the lack of suitable habitat elsewhere, animals forced to move through habitat destruction by burning, cannot accumulate in the remaining suitable unburnt habitat.

Because burning is so extensive, suitable unburnt habitat is at a premium. The ecological equilibrium of habitat supporting an existing population, cannot support additional animals, because resources are at their lowest during the dry season. Moreover, the socio-territorial behaviour of resident conspecifics would preclude this possibility. The fact that they cannot accumulate is evident by their appearance in unsuitable habitat elsewhere as already outlined.

(IV) The (maximum) resident population of Barnadi during the dry season is therefore roughly proportional to the amount of habitat that is not burnt (see also VI).

(V) The animals displaced by burning and forced into moving to unsuitable alternative habitat can reasonably be expected to suffer a very high percentage mortality.

Through the mere unsuitability of alternative cover (e.g. tea estates which provide cover but poor food supplies, owing to constant insecticidal and herbicidal spraying and are also much disturbed by plantation employees), and direct hunting pressure of animals that are known to be killed in the surrounding paddy cultivation areas and tea estates at this time of year. In Barnadi thatch growth is relatively slow and the intervening period to regrowth of vegetation may be as much as two or even three months. The habitat distortion consequent of burning severely reduces the quality of regrown habitat and this, together with the other factors may result in the complete loss of a displaced population. Burning that is very severe in extent could therefore easily result in the extermination of an entire population in any given area.

(VI) The extreme vulnerability of the small pockets of remaining unburnt habitat further exacerbates a precarious situation resulting in the loss of part of the small remaining population in unburnt areas.

These areas are isolated in the post-burning period and in Barnadi are subject to very considerable human and domestic animal disturbance, i.e. these areas are the only source of thatch for cattle fodder and the only source of thatch, firewood and forest vegetables for local villagers in the immediate post-burning period and are much disturbed as a consequence. Similarly these are the only areas where game is to found and all hunting is concentrated on them, moreover game is very easily killed by driving it out of cover into the surrounding open areas.

As has been stated, approximately 80% of the total thatch area was burnt in 1977. Pigmy hog occur in isolated patches of unburnt habitat that total ± 16% of the available areas. All these patches have not been burnt for at least 2-3 years and vary in size considerably, by far the largest being 83.5 hectares. According to my estimation and conversation with forest officials the remaining 3-4% thatchland that was not burnt in 1977 was in fact burnt in 1976. The cover in these areas was substantial but not nearly as dense as in the areas unburnt for several years (i.e. the 16% habitation areas). Again these comprise small isolated pockets and pigmy hog and hispid hare are definitely not resident in these places, though there is frequent evidence of pigmy hog foraging excursions where a particular patch in contiguous with a known habitation area. The actual distribution pattern of the unburnt habitat in Barnadi is also significant in view of the fact that burning is undertaken

illegally by local villagers and herdsmen. Thus the most important unburnt habitat areas are in the immediate vicinity of the range office and beat office and are near or between good firebreaks namely the perimeter road and jeepable tracks.

The estimation of total populated habitat in Barnadi was undertaken simply by measurement and compass bearings of each patch of unburnt habitat. From the sum total area of this habitat it is possible to derive a maximum population estimate by determining the density of animals per unit area. For pigmy hog density was deduced by random sampling (i.e. by measuring areas covered during drives to capture two males for the attachment of radio harnesses and counting numbers of animals seen in each area) and by the subsequent determination of home range by telemetry having given consideration to average sounder composition, i.e. an average 4.5 animals per sounder at this time of year (Oliver 1977). Both methods are rather crude but in the event produced remarkably similar results i.e. 1 pigmy hog/$\pm$5.5 hectares. Therefore the maximum estimated population (prior to an expected birth peak in late April/early May (Mallinson 1977) is approximately 35-40 animals for the whole Barnadi area (though the population is actually lower than this due to direct hunting mortality; see later text for explanation).

Similar figures for hispid hare were not determined and no real data was obtained on current population levels of this species. However the population of hispid hare is undoubtedly low in view of the general scarcity of their distinctive demarcation deposits even in ideal habitat. Moreover their distribution in Barnadi is even more restricted than that of pigmy hog as they were found only in the largest areas of unburnt habitat.

M. K. Ranjitsinh visiting the Barnadi Forest in April 1972 wrote "In the reserve itself there is very little grazing and other factors of human disturbance though I saw evidence of grass cutting for thatch purposes and a few head of cattle on the southern side. On the whole however the reserve has been very well preserved as the areas has been converted to a plantation. There has been effective protection from fire and the area remains a dense high grass biotope".

It is therefore quite apparent that this area has deteriorated dramatically in the last few years. The simple fact of burning has had ecologically disastrous consequences on these resident species. Moreover, the species-habitat vulnerability consequent of burning is exacerbated disproportionately so that hunting, thatch collection and other human disturbance causes further disruption and erosion of the small remaining areas and 'float' populations. The latter being the viable nucleus that represent the future population continuity of these areas.

Analysis of factors affecting population levels in Barnadi and elsewhere

The association between pigmy hog sightings and burning is well known but its profound effects on their population has not been appreciated. Even Hodgson (1847) publishing his original description of the pigmy hog, wrote "that when the annual clearance of the undergrowth of the forest by fire occasionally reveals pigmy hogs, the herd may be assailed to advantage". As has been pointed out, burning is not a new phenomena, it has been practised for generations and yet these species have survived. However, we must consider the species/habitat situation in the present context for it has changed dramatically in the last few

decades with the progressive erosion of habitat and its replacement by agricultural settlements.

Burning is undoubtedly the single most important criteria affecting the population of these species in Barnadi. Barnadi however is by no means unique in this respect as annual burning is an accustomed and accepted practice that is widely considered to be beneficial. Whilst its impact on Barnadi is now self-evident, the issues raised by annual burning are complicated by several related factors. These factors naturally vary from place to place and it is important to analyse them in some detail.

1. *Loss of Habitat through settlement or encroachment*

The demand for new settlement areas with an increasing human population is, of course, the fundamental reason for the reduction in wildlife areas. This demand for land could reasonably be expected to apply to the whole spectrum of Indian wildlife, but in fact pressures for land are unequally applied. The physical difficulties and erosion problems associated with hill settlement have not so far affected these areas in Assam as seriously as elsewhere and as a consequence the primary deciduous and evergreen hill forests are still continuous and extensive.

By contrast thatchlands which are essentially well drained savannah are under the greatest demand for land for settlement and cultivation for they are flat, thinly forested and fertile. This land demand has effectively resulted in the loss of all former high grass habitat for wildlife except in the forest and wildlife reserve areas. Wildlife Reserves and Sanctuaries are few in number and it can be argued that Reserve Forests have assumed a new significance as wildlife areas. Yet as potential wildlife refuges, these remaining thatch areas are very unsatisfactory for they are also under very considerable encroachment, government settlement and exploitation pressure.

This pressure is likely to be maintained if not increased as land becomes increasingly at a premium as established encroachment areas tend to expand rapidly and eviction proceedings are lengthy, expensive and difficult owing to the human problems involved. Additionally the close proximity of forest areas to agricultural settlements not only isolates these areas but inevitably leads to abuses of forest reserves such as poaching, illegal grazing and illegal thatch collection .Control is difficult owing to poor communication facilities and the ease of access to forest areas owing to the long perimeter boundaries common to both forest and the surrounding cultivation areas.

The lack of an intervening 'buffer zone' between cultivation and forest areas is highly significant because the forest reserves are now essentially peripheral to human habitation and the close proximity of thatch areas to human habitation and activity, inordinately increases the risk of accidental or deliberate burning.

2. *Loss of habitat through annual dry season burning*

Annual burning is by no means a new phenomena as systematic and extensive grass-scrub burning has been practised for hundreds of years. However, the situation has changed drastically in the last few decades. Where previously burning extended well into forest areas, there were always areas too remote to be regularly burnt, if at all. Now with settlement extending as far as the Reserve Forests themselves all thatch-scrub areas are in the burning zone and virtually all areas are subject to deliberate burning or liable to accidental burning. At the present time the practice of burning would seem to be comprehensive and

the long practised tradition of dry season burning has not taken this change in circumstances into consideration.

As burning effectively destroys a vast percentage of available (potential) habitat, annual burning obviously serves to keep population of these species at low levels. Any systematic population increases by reproduction will be offset by the amount of available habitat and further reduced by poaching and other factors.

Direct mortality by burning is probably insignificant for pigmy hog (owing to their relative mobility and the coincidental appearance of displaced animals elsewhere) though one hunter assured me he had eaten pigmy hog that had been killed in this way. Alternatively by virtue of their delayed flight reaction (i.e. the tendency to freeze typical of hares) hispid hare may well suffer high mortality during burning.

Undoubtedly however the factor most affecting their population is the temporary loss of ground cover clearly essential for both species. The fact that pigmy hog travel long distances (say two or three miles) to reach the cover afforded by tea estates amply demonstrates this contention. Food and other incidental factors are of secondary importance to the predominant desire to seek cover. In this context we may quote a foremost Indian authority, the late P. D. Stracey (1966):

> "Food and shelter are the essential requirements for existence in an area and the adequacy of supply determines the degree of attraction of an area for a species. These are obviously to be measured at the period of lowest supply which may be in the wet or dry season and the number which an area can carry at such times is called the 'carrying capacity'. All numbers produced in excess of the carrying capacity are obviously subject to loss".

It is evident therefore that the extreme loss of habitat renders the 'carrying capacity' small, i.e. directly proportional to the amount of unburnt habitat. There is no doubt at all that the dry season is anyway the period that the population of these species are subject to the greatest natural pressure as resources, food/water supply etc. are at their lowest and the consequent destruction of habitat (shelter) by fire therefore has disastrous consequences on the resident population. Stracey goes on to say:

> "Similarly shelter may be measured in terms of quantity and|or quality and lack of mal-distribution of this factor is reflected in a low population. Shelter must protect the species from the elements as well as from enemies and must ensure safe feeding and breeding facilities. It must also satisfy the instinctive needs of the species and the 'animal pattern'. The instinctive behaviour pattern of a species is relatively fixed and modification of the conditions of shelter which it requires will bring about a reduction in its numbers in the locality".

Thus burning not only reduces habitat availability enormously, it also isolates remaining unburnt habitat so that other deleterious factors are concentrated on what is left to further reduce the remnant population.

Thus the situation for these species is very serious because of burning and becomes acute for the remaining population in the post-burning period.

3. *The destruction of habitat by forestry*

The advantages of burning for forestry practices are quite clear cut but must be reviewed here in the context of general discussion. Not unnaturally the primary consideration with respect to burning the Reserve Forests is its effect on forestry practices and its effect on wildlife is at best a secondary consideration, if it is considered at all.

Annual burning is an official Forest Department policy in many areas partly as an aid to forestry itself and partly to prevent burning

by other persons at a later date which would be more harmful to forest plantations. In essence therefore most burning by forestry officials is 'early' controlled burning in plots by fireline demarcation. This deliberate controlled burning is undertaken when the grass is not 'tinder-dry' in December-early February. Whilst this controlled burning does in fact sometimes get out of control it is far less harmful to young plantations than later uncontrolled burning in the height of the dry season. The latter can easily destroy a whole and very valuable plantation area, as happened in Khalingdaur Reserve Forest in the early 1970's. Thus early burning effectively clears thatch-scrub undergrowth which represents a serious fire hazard at a later date. The fact that the 'thatchlands' are the main target for afforestation programmes renders this fire hazard a very real threat in view of the ease with which dry season fires are started, particularly when so many persons, both official and unofficial, have access to forest areas.

Another reason for deliberate burning has already been outlined, i.e. the clearance of thatch-scrub which competes with young plantations for light and other resources. This clearance is a necessary prerequisite for the successful growth of young trees and for this reason thatch may also be regularly cut following rapid growth after the 'chota' rains.

Similarly thatch burning is also necessary to maintain high thatch yield as regular annual burning inhibits the growth of most other species and ensures an even growth of thatch that is of high quality and quantity. By the same token this also facilitates its harvesting as a commercial crop which is sold on a tender system, the thatch being collected into bundles and auctioned. The thatch-mahal itself is collected between September and April (though specific dates vary from locality and locality) and it provides an important source of revenue to the Forest Department. Nearly all large expanses of thatchland are therefore subject to mahal, though not all areas are burnt by forestry officials. However virtually all areas are in fact burnt one way or the other and thatch collection (whilst not a serious disturbance in itself as it concentrates mainly on burnt areas) obviously encourages burning as thatch yield is undoubtedly improved. Moreover, many areas of thatch that are not subject to an official mahal are still burnt for domestic thatch collection by villagers or by local forestry officials for their own purposes even though the thatch thus produced is often far in excess of their actual needs.

In view of the ecologically disastrous consequences of burning on resident wild species, forestry for afforestation and thatch-mahal purposes, directly results in the destruction of the vast majority of otherwise suitable habitat. It is therefore apparent that there is a direct conflict of interests between wildlife and forestry in these areas. It is true that the Reserve Forests are not wildlife areas, but for the pigmy hog and hispid hare they represent the only areas of distribution except for the Manas Sanctuary. It is irrelevant whether the burning consequent of forestry and thatch collection is the early controlled burning by forest officers or later uncontrolled burning by other persons for the effect on the habitat is equally disastrous for the ecology and conservation of these species.

Whilst burning is necessary for the successful growth of young trees, mature plantation could easily support thick thatch-scrub, but in areas like Barnadi thatch-mahal effectively precludes this possibility. Though most plantations are mono-culture, where trees are widely spaced the effect on undergrowth is negligible, but close planting for species like teak also

prevents the growth of cover in mature plantations. Elsewhere, undergrowth burning is undertaken (e.g. for sal in Balipara Reserve Forest) to prevent competition to germination from mature seeding trees.

Lastly the oft-mentioned argument that if thatch-scrub is not regularly burnt it would be completely superseded by forest, is in my view highly questionable. Basically the contention of this argument is that open thatch or grassland as a habitat is only maintained by burning and if burning was discontinued it would be quickly and successively displaced by secondary and eventually primary forest. It is, of course, true that there is a long term dynamism in the structure of habitat, but long term trends are irrelevant to these species when the short term effects of burning are so catastrophic. Moreover it is not possible to have it both ways, if the thatch-scrub of natural savannah is burnt to facilitate the growth of young trees in plantation, then that same cover will also inhibit the growth of natural forest. Certainly forest clearings revert back to forest if left (assuming erosion is not severe), but we are dealing mainly with natural savannah that has survived largely unburnt in formerly remote and inaccessible areas. This natural savannah may be thinly forested and still survive as thatch-scrub, indeed mature plantations of widely spaced trees could well represent a most important possible refuge for these species. There is evidence that if left unburnt, there is a noticeable increase in secondary forest growth with the relatively rapid appearance of such fast growing trees as simul, sishu and khier (D. K. Lahiri Choudhury, pers. comm.) though these tend to be widely spaced and the thatch-scrub is not deleteriously affected by this process. In fact one area of Barnadi approximately 63 hectares in extent was comprised entirely of mature secondary forest and had a very heavy thatch-scrub undergrowth and this was one of the best areas for both species. It seems unlikely that the typical primary forest would entirely displace this habitat and if burning continues at its present rate the argument would anyway be academic (as it would take too long for consideration in the urgently required short term conservation of these species). The management of open savannah for wild species would therefore be much better directed at actual management of tree growth (e.g. by ringing trees) than by burning entire areas to remove this doubtful eventuality.

4. *The destruction of habitat by burning for grazing*

Whilst the arguments about afforestation and thatch-mahal do not, or should not apply to Sanctuaries and other declared wildlife areas, annual burning of the grasslands is nonetheless undertaken to a great extent in these areas. Part of the reason given is that controlled burning is also less destructive to habitat and wildlife than the likely subsequent uncontrolled burning at a later time. There is a very real risk of fire even in Sanctuaries during the dry season from tourists, sanctuary officials, labourers and bordering settlements and controlled burning does enable large and mobile stock to get out of the way of fire and it is less destructive to forest. The additional argument that most species migrate during the dry season and are therefore not affected is fallacious and is anyway inapplicable to these and other resident species as we have seen.

However, controlled burning is also undertaken in Sanctuaries and elsewhere to improve fodder for grazing herbivores and I would contend that there is considerable fault to find with this argument. Whilst it is true that grass/thatch yield (i.e. fodder) is undoubtedly in-

creased by burning in the same way as that undertaken for thatch-mahal, there is no evidence that shortages of fodder is the factor that is controlling the population of any of the grazing ungulates in these Sanctuaries. Species populations are always controlled by the least favourable factor in any particular environment, and it is highly doubtful that in a high-grass biotope fodder is in short supply (except perhaps ironically in the post-burning period). It is true that the young shoots that grow after the 'chota' rains in burnt areas are a favoured fodder, but it is hardly possible to justify the distortion caused to the habitat by the selective effects of burning on this account. Even if burning could successfully bring about an increase in herbivore population resulting from improved fodder yield, the pursuance of this policy would result in the artificial maintenance of an over-optimum population of a few species at the expense of a whole variety of others.

Stracey (1963) summarises a section on the protection of game habitat by writing:

> "The lesson to be drawn from all this is the need to preserve intact, as far as possible, the biotic complex so as to ensure the free interplay of these forces of nature of which we have so little real comprehension. Any attempts at protection of the forest as such or as a game habitat by artificial means, must be embarked upon with the utmost caution, particularly when they aim at the reduction or elimination of one or more species and the maximum reliance should be placed on biological or natural methods of control."

It need hardly be said that burning is neither biological or natural, certainly electrical storms can cause fire but the frequency with which this happens in the dry season is negligible, electrical storms are essentially a wet season phenomenon.

There are only two Sanctuaries in the known area of distribution of the species, i.e. Manas and Sonai-Rupa, and both are subject to extensive burning. Manas is probably the most important area for the future conservation of pigmy hog/hispid hare but it is extensively and deliberately burnt over most areas for the above mentioned reasons even though it does not support a very heavy population of grazing herbivores. Hispid hare have not been recorded from Sonai-Rupa and pigmy hog are probably extinct now in this area though they were formerly known to occur there. Regular burning for thatch-mahal in this sanctuary until two years ago may well have caused the disappearance of this species. Part of Sonai-Rupa is still burnt and this is not controlled burning but 'accidental' burning primarily by herdsmen from a mixed cattle and buffalo 'khuti' (permanent graziers camp) who have grazing rights in the sanctuary.

Burning by villagers and herdsmen for the improvement of grazing for domestic herbivores is a very important factor in some areas such as Khalingdaur Reserve Forest where herdsmen from a two hundred head buffalo khuti have totally burnt approximately 9 sq. miles of thatchland in an area that was previously known to support pigmy hogs. No pigmy hogs have been seen this year which is most unusual, and quite conceivably represents the loss of this population. This burning may have been deliberate to improve grazing (there is no thatch-mahal in this area) or accidental as the herdsmen are smoking or cooking their meals in the forest. Grazing concessions in forest areas enormously increases the risk of burning even if the burning is not deliberate. In Barnadi the illegal grazing by domestic cattle represents a source of fire from attendant herdsmen and in some parts the intensive grazing severely curtails the growth of thatch following the 'chota' rains. More significantly perhaps the only source of thatch for fodder is the immediate post-burning period in the

unburnt areas that support the residual population of pigmy hog and hispid hare. These areas in Barnadi are therefore subject to considerable and continual disturbance by both cattle grazing the area and more particularly by herdsmen and villagers collecting bundles of thatch for fodder for domestic animals and for their own purposes. Relatively few Reserve Forests have grazing concessions in this area and grazing of domestic animals is not allowed without prior permission that may be granted in special cases (e.g. to forest villagers who have grazing rights for their own cattle on a ten head per household basis and these are censused every year). The heavy illegal grazing is exceptional in Barnadi and in view of the shortages of game species in this highly disturbed areas, grazing itself is probably not particularly deleterious if it was not so concentrated, especially on the unburnt areas following seasonal burning. However, even light grazing by a few domestic animals involves human activity with an inherent and serious associated fire hazard that is much more significant in these respects, e.g. Khalingdaur.

Hunting

Direct mortality by hunting or poaching is also a serious threat to these species. Again we are faced with this problem that hunting, particularly of pigmy hog, becomes far more significant in the post-burning period. Barnadi is regularly visited by hunters (poachers) working independently or in small parties from village settlements and tea estates. These people naturally concentrate their activities mainly on unburnt areas for the obvious reason that these are the only areas where cover (and therefore game) is to be found in the high grasslands following burning. The isolation of the small unburnt areas therefore facilitates hunting enormously as hunters can be deployed only in these areas and can screen randomly for game, set snares or gin traps or drive animals out of cover. I can testify to the effectiveness of the last method because this was the method used under permit to catch pigmy hog in nets for the temporary attachment of the radio harnesses during the study. Game such as pigmy hog, that is driven out of cover is either run to exhaustion on surrounding open land or killed with bow and arrow or shot gun as it breaks cover. To my own certain knowledge at least five animals were killed in Barnadi in this way during the late March to May period. This may not seem a particularly high mortality but this in fact represents direct poaching on the very small remnant breeding population that is the main basis for the continuance for the species in the area. Therefore those pigmy hog known to be killed in this period in 1977 is actually approximately 14% of the total estimated population for this whole area.

It is well known that pigmy hog and other species are most easily caught after the grasslands have been burnt and it is no coincidence that all captive animals caught since 1971 have been captured in the period. As one hunter told me "If you want to catch pigmy hog you have to do it after burning but before the rains when the grass grows so there is more cover and hunting is difficult."

Not all hunting takes place in the Reserve Forests for the main pigmy hog actual hunting mortality is likely to occur in the displaced populations found on local tea estates as already outlined. But whatever the source, pigmy hogs were formerly commonly to be observed for sale as food in local bazaars during this period and the original Attareekhat acquisitions were obtained in this way. They are rarely sold in bazaars now as they are likely to be recognised by forest officials and

the hunters and retailers are therefore liable to prosecution. There have been no prosecutions to date however, though they are still hunted regularly in Barnadi during this period, though animals are usually butchered immediately so that they cannot be easily recognised.

Gin traps are also easily available for sale in bazaars and the large number of disabled animals purchased for the tea estate captive stocks testify to this method of hunting (Mallinson 1971). Hispid hare also caught and killed in this way. Of course, gin traps are largely indiscriminate, but so too are the hunters themselves for almost any animal caught is liable to be eaten or parts of it sold for medicinal purposes.

This lack of discrimination is even more directly significant for hispid hare as most local people simply do not distinguish between hispid hare and ordinary hare (*Lepus nigricollis*) and the latter can be hunted legally in agricultural areas. Some hunters of course do appreciate differences between the two sorts of 'rabbit' (hence the local dialect names: 'Nul Keria', 'Khagra Katta' or Ekra Kata Shoha' for hispid hare and 'Loha-Pohu' or 'Khargosh' for the Indian hare) but they still fail to appreciate that you can hunt one sort and not the other or the reasons for it. Unlike pigmy hog which hunters are cautious about hunting, the rarity of hispid hare is not known and even most local forestry officials do not recognise the species or its status. Information about hispid hare is consequently much harder to come by and this is reflected to some extent in the incompleteness of the data collected about this species. Apart from gin traps and snares, both sorts of hare are mainly hunted at night with a torch and this method may be so refined by experienced shikaris that animals can be approached over open ground within physical striking distance. Hunting parties with torches were to be regularly seen screening paddy fields systematically for foraging hares that have emerged from the Reserve Forest. The villagers claim that they are not poaching as the animals are outside reserve boundaries and are anyway damaging their crops. The author never saw hispid hare whilst looking for them at night with a torch, though there were many Indian hare active in these fields. However reliable sources of information assure of the similar activity of hispid hare and I saw a skin of one that had been killed in this way.

Poaching in Barnadi is probably more serious than in most Reserve Forests and in some poaching is probably negligible at the present time. In Barnadi the long common perimeter to settlement areas is again significant as it renders anti-poaching policing difficult. Poaching in Manas for these species is probably not serious if it occurs at all, as other game is more profitable and anti-poaching measures have reduced poaching significantly (P. Lahan, pers. comm.). However most pigmy hog and hispid hare populations are unlikely to be in the vicinity of settlement areas owing to the extensive burning.

Other sources of disturbances

Primarily these include such (illegal) activities as collection of forest vegetables, firewood, domestic thatch collection out of season (i.e. between 31st April and 1st September) and other forest resources. Some areas such as Barnadi also have by-ways through the forest which are used by local settlers as well as forest villagers. These activities themselves are not particularly harmful other than the fact that they again disturb the small unburnt areas for they are the only source of such resources in the post-burning period. More particularly, such activities are also a serious fire hazard especially if the burning of most areas has

been undertaken early, thereby leaving the remaining unburnt areas highly vulnerable to fire for two to three months prior to the chota rains.

Areas of distribution in N. W. Assam

Owing to the difficulties mentioned earlier it was not possible to visit all known or likely areas of distribution. Where it was not possible to visit personally, attempts were made to gather as much information as possible from local forestry officials or employees, local villagers and shikaris and similar sources of information. For some of these areas there is no information available regarding the presence or absence of the species, but particular Reserve Forests or Unclassed State Forests have been included in a summary of known distribution as they fall within or between known localities and are known to encompass similar habitat areas.

There are four 'divisions' in north-western Assam that fall within this known area of distribution, i.e. (from west to east) Kachugaon, Haltugaon, North Kamrup and Darrang Divisions. The two most important districts are Darrang and North Kamrup Divisions; and these areas have been assayed as well as time and circumstances permitted.

1. **Darrang Division**

Gophur Reserve Forest: Pigmy hog are definitely known from this area at the present time and there are also recent records of hispid hare. There are approximately 16 sq. kilometres of thatchland on the north-eastern edge of the Reserve, but this whole area is subject to two separate thatch-mahal concessions and as nearly all areas are burnt the pigmy hog population must be small. No grazing in this area, but formerly much encroachment although over 3,000 people have been evicted. The thatchland reclaimed in this way is being afforested with simul and udal plantations however.

The geography of this area would make it suitable for the prevention of burning in some areas as access to thatch area is limited to the western river boundary, as it is otherwise surrounded by primary forest.

Naudaur Reserve Forest: Pigmy hog are also definitely known from this area at the present time though again the population is very low. No records of hispid hare. Total reserve area is 67 sq. kilometres but more than half of this area is leased as a firing range. Only about 30 hectares of grassland within Reserve boundary and most of this borders the Bordukari River and as it tends to get waterlogged is unlikely to support pigmy hog. A large thatch-bari on the outskirts of the reserve is under disputed ownership but is, like the 'char' thatch area within reserve, subject to mahal and is totally burnt. Small patches of thatch within the forest itself are not subject to official mahal but are burnt for private thatch collection by forest officials, though much of the thatch produced is superflous to their domestic requirements. These latter areas could well be protected from burning. Pigmy hogs are only seen in these latter areas and always in early April following burning.

Balipara Reserve Forest: Pigmy hog occur in one small area of this Reserve but no records of hispid hare. The population must be very small for this area is only approximately 200 - 300 acres and is comprised of mixed thatch—tara (*Cardaman* sp.) jungle, though this is presently undisturbed. However there is a government-granted collective farm immediately to the south-east of this area which might easily affect it. Only other thatch is char grassland on the north-east side of the Borelli River, which is subject to a thatch-mahal but

as it also gets waterlogged or flooded during the monsoon it does not support pigmy hog. Efforts should be made to maintain protection of the one small area where pigmy hog are believed to occur.

Sonai-Rupa Sanctuary: Pigmy hog probably extinct in this area, no records for hispid hare. This sanctuary is part of the Charduar Reserve Forest, but it has not been maintained or developed as a wildlife area. Regular burning and thatch-mahal was stopped in 1975 but pigmy hog had long disappeared by that time having last been seen about 30 years ago. Some areas within an approximate 13 sq. mile thatch-scrub belt are still burnt by herdsmen from a mixed cattle and buffalo khuti who have permanent settlement and grazing rights in the sanctuary. The State Government has also leased approximately 63.8 sq. kilometres of the sanctuary to the army as a firing range, including heavy artillery and for large scale troop manoeuvres. The army has applied to lease a further area of approximately the same acreage, though the Forest Department has requested the army to vacate as it hampers operations to develop the sanctuary. There are no reports of the army actually killing any game but the disturbance is obviously considerable. This would be an ideal area for the reintroduction or translocation of pigmy hog if the sanctuary was brought up to its nominate status.

Rowta Reserve Forest: Pigmy hog definitely known to occur in this area but the population must be extremely low. No records of hispid hare. The one area of thatchland, approximately 80 hectares in extent, has a complete mahal and the whole area is subject to uncontrolled burning usually in March. Only a very small strip of mixed thatch-scrub forest running along the edge of this mahal area is unburnt. Pigmy hogs were seen this year in late March after burning. There is no grazing in this area, but extensive timber extraction.

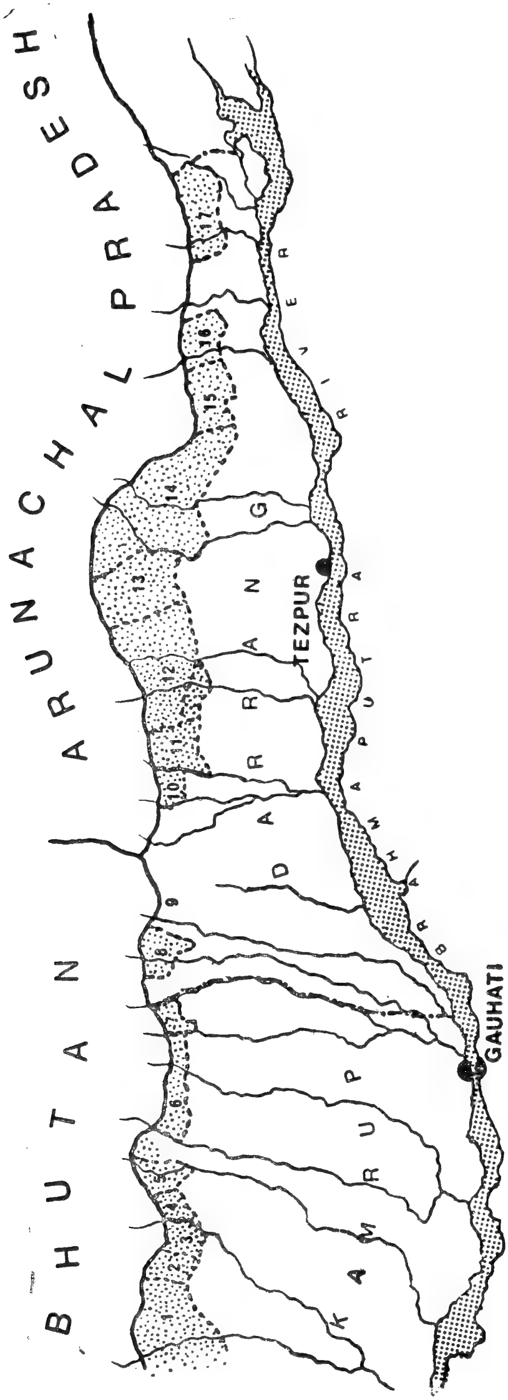
The geography of this area could well protect the thatch against fire as access is well guarded and the thatch area is well within the confines of the forest. Moreover the value of the thatch-mahal is very small.

Corromore Unclassed State Forest: Pigmy hog occur in this area but again population probably very low as nearly all areas burnt. No record of hispid hare. Wild elephant in the area prevented closer examination of the one small area likely to support pigmy hog on the western side. Little encroachment as yet but dwellings have appeared over the last year.

Khalingdaur Reserve Forest: Pigmy hog definitely found up to 1976, though now much reduced if they survive at all. No definite records of hispid hare. Very large areas of thatch on north and western side of this area, but these have been entirely burnt mostly by herdsmen of a buffalo khuti. Records of pigmy hog on Nonaipara Tea Estate are derived from population formerly living in Khalingdaur which is immediately to the north of this garden. However this population area has now been converted into a plantation and this whole habitat zone is now subject to controlled burning and no pigmy hogs have been seen this year. There is no thatch-mahal. Two large thatch areas to the east are also deliberately burnt despite having a natural fire break afforded by the Dhansiri River. Previous records of pigmy hog in Haltigaon and Majuli Tea Estates are derived from animals on this side. This eastern area could be protected from fire and would be an ideal area for pigmy hog if the animal still survives there.

2. **North Kamrup Division**

Barnadi Forest Reserve: Pigmy hog and hispid hare definitely found here. Still one of the



Scale 1' — 16 miles

NORTH KAMRUP DIVISION

Key 1. Manas

2. Doadhari Reserve Forest
3. Batabari Reserve Forest
*4. Diwara Reserve Forest
5. Subankhata Reserve Forest
6. Darranga Reserve Forest
7. Barnadi Reserve Forest

DARRANG DIVISION

8. Khalingdaur R.F.
9. Corromore U.S.F.
10. Rowta R.F.
11. Charduar R.F.
12. Sonai-Rupa Sanctuary
13. Balipara R.F.
14. Naudaur R.F.
*15. Biswanath R.F.
*16. Behali R.F.
17. Gohpur R.F.

* Reserve Forests are comprised entirely of primary forest.

Fig. 3. Reserve Forest distribution of the most important areas for pigmy hog and hispid hare in North Kamrup and Darrang Districts of North-Western Assam.

most important regions for these species, this area has undergone progressive deterioration and it is unlikely that either species will survive if this pressure continues. Thatch-mahal and afforestation programmes over whole area, coupled with a tremendous amount of illegal human activity. This area is very difficult to protect owing to long perimeter boundary to surrounding cultivation area and it is doubtful that proposed protection measures will be effective long term. For details see previous section.

Darranga Reserve Forest: Pigmy hog definitely known to occur in the eastern side though population probably low. No definite records of hispid hare. There is a continuous strip of thatch and all along southern half of this forest, but nearly all thatch is burnt and there is a thatch-mahal concession for this entire region. There is an army firing range on the western side. Fire protection measures should be taken in the eastern side though long common forest-cultivation boundary, similar to Barnadi, may render this difficult.

Subankhata Reserve Forest: Pigmy hog probably found in this area though flooding of access roads prevented confirmation. No definite records of hispid hare. A small thatch area on southern side may well support pigmy hog, though this area is subject to mahal and is largely burnt. This thatch area runs north-south, so there is a relatively short common boundary with cultivation areas to the south which would facilitate protection against burning and the value of the thatch-mahal is small. An additional small Reserve Forest area to the south-east, i.e. Morapgaldia Reserve Forest, is a good thatch area, but is entirely burnt and all parts subject to mahal and afforestation and therefore unlikely to support this species.

Batabari and Doadhari Reserve Forests: No definite records of pigmy hog or hispid hare, but flooding prevented access to the region. Small thatch areas in these reserves may support pigmy hog, but despite lack of thatch-mahal, nearly all areas are burnt.

Manas Sanctuary: Pigmy hog and hispid hare both found in this region which is probably the single most important area for the future conservation of these species. However the population of both species must be much lower than it should be owing to the very extensive early burning for prevention of accidental burning and the improvement of fodder. There is a total of approximately 40 sq. kilometres of thatchland in sanctuary area, of which approximately 12 sq. kilometres on southern side and 15 sq. kilometres on the western side of the Manas River make up the bulk of this total though practically all of both these areas are burnt. Small areas within forest belts and at the edges of the large thatch belts remain unburnt and harbour the resident populations of these species. Pigmy hog have been recorded from several places in the sanctuary including the eastern side in the former Kakihabari Reserve Forest, in patches in the central and southern areas and on the western side of the Manas River. Fire prevention measures in Manas are wholly directed at early controlled burning by firelines to prevent the likely accidental burning from persons having access to the sanctuary and from neighbouring border settlements. However efforts must be made to reduce the extent of burnings in view of the importance of Manas for these species.

3. Hultugaon Division

This area was not visited. There is a reported sighting of pigmy hog near Rumikhati (D. K. Lahiri Choudhury, pers. comm.). Other reports of pigmy hog and hispid hare have been recorded in the vicinity of Goalpara

Forest Division to the south but these have not been confirmed recently. A hispid hare was collected there in 1956. There is a large belt of approximately 60 sq. kilometres of mixed thatch-scrub to the north of this division between the Sarbhanga River in the west to the Kanamakra River in the east (S. K. Chetia, in litt.) which may well support these species though no reports of them have filtered through. There is some human habitation in this latter region and much of this area is burnt by the villagers who collect thatch for their own purposes though there is no official thatch-mahal. This area needs further investigation.

4. **Kochugaon Division**

This area was not visited and there is very little information available appertaining to it. However pigmy hog have been recently reported from one locality, i.e. near Raimona Forest Rest House between the Janali and Rouya forest areas (D. K. Lahiri Choudhury, per. comm.). This area also needs further investigation.

The apparent poor distribution of hispid hare is significant, for it reflects not only a very poor local knowledge of this animal but a probable real paucity of the species over this known range. Whilst it is important to consider that some of these areas may well support small populations of hispid hare, some almost certainly do not (e.g. Balipara Reserve Forest) as local shikari knowledge is sound and if the species were to be found there it would have been reported. By contrast, whilst the range of the pigmy hog may seem considerable, it must be remembered that in view of the ecological instability brought about by the burning of the vast majority of all these areas, this species must have an extremely tenuous hold in most places.

The only way of estimating resident populations in these areas is by ascertaining the total area of inhabited unburnt thatch-scrub, and this of course varies year by year. Whilst this was done in Barnadi in 1977, it was clearly not possible to do this over the entire range of distribution and I have made no attempt at a total population estimate for pigmy hog, though it is felt that it is unlikely to be more than one hundred and fifty to two hundred animals and may well be considerably less than this. Moreover any population estimate is largely meaningless in view of the extreme vulnerability and instability of the habitat, and therefore of the species. Suffice to say that population levels are certain to reflect this ecological instability and it is certain that pigmy hog and hispid hare numbers will continue to decrease unless their environment can be stabilised by the prevention of burning in some areas.

Conclusions

It is quite apparent that these species have undergone a dramatic decline in distribution over the past few decades and that this process is continuing in the last remaining habitation areas of N. W. Assam. Even such a cursory analysis of the pressures affecting this remaining habitat and its resident populations of these species shows that their future is also extremely precarious throughout most, if not all, of their present range of distribution. The fact that the 'thatchlands' are essentially flat, well-drained savannah which is ideal for agriculture and forestry, has meant a disproportionate loss of habitat for hog and hare over their entire former range. Furthermore, not only have the processes of settlement and encroachment reduced former habitat areas to within or even beyond declared forest boundaries, but that the vast majority of whatever natural habitat remains is further despoiled

by burning and other forestry practices.

The situation for these species is particularly acute for a number of reasons, not least of which is that the surviving populations are largely restricted to Reserve Forests, and these areas are not actually wildlife areas and have no real policy regarding wildlife conservation. Of declared wildlife areas, only Manas Sanctuary supports known populations and the vast majority of otherwise suitable habitat in Manas is spoilt by the widespread seasonal burning. Therefore whilst we must appreciate that the primary function of the Reserve Forests is the commercial exploitation of the forests as a resource, it should also be appreciated that they must have additional significance as an extremely important last refuge for these species, and they do support most of the total surviving populations.

Forestry and wildlife are largely incompatable however, and at the present time we are witnessing the progressive decline of wildlife habitation areas that is primarily a function of dry season burning coupled with the increasing exploitation of thatchland for afforestation, thatch-mahal and grazing. So great is the rate of destruction of this environment, that it is somewhat surprising that they have continued to survive at all in many of these areas. As it is, we can certainly expect the systematic loss of most of these populations over the next few years if the present pressures on this habitat continue, as they are almost certain to do.

All results lead to the inevitable conclusion that the long tradition of dry season burning as the fundamental problem affecting the remaining populations. However the effect of burning on small resident species has never been seriously considered or appreciated. Neither has the change in circumstances been taken into account, i.e. the reduction in wildlife areas so that few are now too remote not to be subject to burning. As we have seen, this burning of thatch-scrub effectively destroys, or severely distorts, the vast majority of otherwise suitable habitat. This serves to keep resident populations at low levels that are approximately proportional to the amount of habitat left unburnt for several successive years. Moreover the nature of uncontrolled burning obviously results in a good deal of variance in the extent (severity) of burning year by year, and a particularly severe burning can reasonably be expected to result in the complete extermination of whole populations by the total, or near total, destruction of available habitat.

Official fire policy in Reserve Forests is essentially the controlled early burning where fire is a hazard to plantations and though uncontrolled burning is not actually allowed, it has not caused much concern where it has not directly affected such interests. The early burning that is an integral part of many forestry operations does serve to inhibit or prevent later accidental or deliberate uncontrolled burning and it is therefore undoubtedly good for forestry purposes, as tree growth is less affected and thatch yield is improved. This is particularly true where later uncontrolled burning is not so much a risk as a definite probability owing to human activity in forest areas or the close proximity of thatchland to bordering settlement and cultivation areas, e.g. Barnadi. This incidental burning by other persons is a very real problem as burning during the dry season is a tradition of long standing and in fairness it must be said that even if the prohibition of burning was better enforced by the Forest Department, it would still be unlikely to be prevented in some areas (M. A. Islam, pers. comm.). Moreover fire prevention is costly and difficult and though easily started, fires are very difficult to control.

Even so, the present extent of burning, either controlled or uncontrolled, cannot possibly be justified. Many areas, e.g. parts of Naudaur Reserve Forest, are burnt by forestry officials solely for their own domestic purposes even though they are unlikely to be burnt by other persons and there are no forestry operations in these small areas. The thatch yield produced by this burning is far in excess of these domestic requirements, which could easily be met without burning. There is no justification for burning for thatch when optimum yield is not required. In other areas, e.g. Rowta Reserve Forest, optimum yield is required for a total mahal is the only area of thatch, yet the revenue obtained from this mahal was only six thousand rupees in 1976 (approximately four hundred pounds sterling). Almost the entire thatch area in Rowta is burnt for this mahal and as a consequence the pigmy hog population is so small that it is almost certain to disappear altogether if the present burning continues. In Khalingdaur Reserve Forest the known indigenous pigmy hog population is now quite probably extinct as a result of thatchland burning even though there is no mahal. Controlled burning in Khalingdaur is undertaken only in plantation areas and the indiscriminate uncontrolled burning that occurs everywhere else in the Reserve is undertaken according to the whim or carelessness of herdsmen that have access to these areas from the official buffalo khuti. The total of approximately 9 sq. miles of otherwise prime thatch-scrub habitat that was burnt in 1977 is a result of these herdsmen's activities. Yet the revenue obtained from the grazing rights of this two hundred head khuti is only six rupees per head of buffalo, i.e. one thousand two hundred rupees (approximately eighty pounds sterling). Clearly therefore the revenue obtained from such activities is very small, whilst the cost is very high in terms of wildlife and typifies the way in which these Reserve Forest populations are being (unwittingly) squandered at the present time.

It is of course unrealistic to think that much thatchland savannah will be left for wildlife in Reserve Forest areas for there is an undoubted conflict of interests between forestry and wildlife. Moreover forestry exploitation is not just revenue—dependent for there is a genuine human interest in much of this exploitation particularly for thatch in view of its importance as a cheap and satisfactory roofing material. Burning for thatch-mahal will thus continue to account for a majority of this habitat for burning does improve thatch yield and facilitates its extraction and there is very little thatch available outside Reserve Forests (though many tea estates have thatch-bari's and auction thatch surplus to their own requirements). But there are many official mahals in areas where these species do not occur, but in those indigenous areas that have been listed, the burning (usually uncontrolled) consequent of mahal is very likely to eliminate these populations. In this context G. S. Chaudhury (pers. comm.) is intending to institute a policy in Barnadi of early and restricted thatch extraction (September to January) with no burning and this could be most significant for the populations there. Optimum yield would however be sacrificed, and in view of the ease with which Barnadi is burnt by miscreants at the present time, fire prevention measures would have to be improved enormously. It would be much more preferable if mahal were abolished totally (or in certain parts that could be protected) in the most important pigmy hog and hispid hare areas, as this would eliminate much of the necessity for burning. By the same token unofficial thatch collection by villagers for domestic purposes

would also be outlawed, as such activities are an inherent fire risk and greatly disturb the pockets of unburnt habitat in the post-burning period. The discouragement of private and illegal thatch collection by the prosecution of offenders would do much to prevent thatch fires by reducing the risk of accidental or deliberate arson. Similarly the domestic thatch requirements for forest settlements and forestry officials should be met without burning, or preferably with thatch supplied from elsewhere or thatch substitutes (such as rice straw, palm fronds or ideally, corrugated iron). Localised incidental burning for such purposes is particularly destructive as it tends to occur in the only areas likely to support species that have been eliminated elsewhere by official mahal.

Yet forestry itself need not necessarily result in the exclusion of resident species from these thatch areas even though this is undoubtedly the current trend. Most burning for thatch-mahal is presently uncontrolled, but if burning was carefully controlled there could be room for compromise, such as is envisaged for Barnadi. Mahal could be restricted to specified mahal areas within particular thatchland belts where these species are known to occur. Afforestation could also be adapted so that it did not conflict directly with wildlife interest. M. K. Ranjitsinh (in litt.) has suggested rotational planting and extraction actually as a means to conserve thatch-scrub habitat. Many plantations are on long cycles even fifty or sixty years (P. C. Das, pers. comm.) and thinly planted established trees could support a thick thatch-scrub undergrowth that would be ecologically stable for many years provided it was no burnt. Such areas support pigmy hog and hispid hare in Barnadi and the area of mature mixed secondary forest also in that locality, demonstrates that even fairly substantial cover does not preclude the heavy undergrowth that will support a rich fauna. Thus young plantations could be subject to controlled seasonal burning until established, as would suit forestry purposes, whilst adjacent plots could support these species. Such a system would have decided advantages provided a policy of fire prevention was adopted (rather than undertake controlled burning to prevent uncontrolled burning) as animals eventually displaced by the cropping of sufficiently mature plantation, would have spill-over habitat in the young but established plantations. In this way, what are at present highly negative aspects of forestry in terms of wildlife, could be made to make a very positive contribution to conservation, without loss of revenue.

The present policy of controlled burning to prevent uncontrolled burning is not a solution for wildlife as controlled burning is basically just as destructive to habitat (and therefore to wildlife) as uncontrolled burning. Both result in the total short-term loss of cover and other resources and the long-term distortion of habitat brought about by the differing fire resistance of plant and animal species. Thus the current practise of controlled early burning in Sanctuaries to minimise the risk of uncontrolled burning is merely a 'soft option' that is highly unsatisfactory. To prevent wholesale uncontrolled burning is one thing, but to justify wholescale controlled burning for fodder requirements for grazing ungulates is grossly irresponsible in my view. But many remote or inaccessible parts of the Sanctuaries in Assam, Manas included, are deliberately burnt on these grounds, even though there is very small chance that they would be burnt accidentally. Not only should such places not be burnt, but access to many such areas could easily be restricted to tourists and labourers during the height of the dry season to minimise the risk of accidental burning. Also pro-

paganda about the risks of burning should be displayed in areas where access cannot be restricted. There should be absolute prohibition of burning in areas which are also naturally less susceptible to fire hazard by virtue of the topography of the region, e.g. with natural firebreaks such as wet or dry watercourses or stretches of primary forest. Moreover other methods of control should be sought in Sanctuary areas where there is a high fire risk owing to their proximity to human activity. At the present time the cutting and burning of firelines is undertaken for the controlled burning of large areas, but these methods should be adapted to inhibit or prevent the spread of fire over large areas.

Moreover, not only is burning highly deleterious for these species, it is now actually illegal in Sanctuaries under Chapter IV, Section 30, of the Indian Wild Life (Protection) Act, 1972, which was ratified by Assam on 16th January 1977. Under this Act the argument about burning for the improvement of fodder is important as it could be argued that burning should be allowed under Section 33, Clause (c) as "measures for the improvement of any habitat." In my view this is clearly inapplicable as burning is totally destructive to the habitat of some species, and is only of highly doubtful merit for grazing ungulates, as argued earlier. However, this same section could allow for the burning and cutting of firelines to prevent the widespread uncontrolled burning, for which widespread controlled burning is partly undertaken.

These Sections of the Act are only applicable to Sanctuaries and National Parks and there is no legislation for the protection of their habitat over most of their range of distribution, i.e. in the Reserve Forests. The legislation applicable to these animals by their Schedule I categorisation only applies to hunting (in its widest sense) or possession of live animals or the whole or parts of their bodies. Hunting is anyway not allowed in Reserve Forests and although hunting still remains a problem in some areas (particularly in Barnadi Reserve Forest), it is not the major problem. The major problem is the destruction of their habitat.

This is a crucial argument. By virtue of the fact that these species are primarily endangered by the destruction of their habitat, they remain effectively unprotected in Reserve Forests. Thus as it stands at the moment, the Indian Wild Life (Protection) Act has little meaning or relevance to most populations of either of these highly endangered species. (This, of course, also serves to emphasise the tremendous importance of reducing the high level of burning in Manas, for this is the only area where the habitat of these species is legally protected).

Whilst reviewing the conservation measures that need to be adopted for the protection of pigmy hog and hispid hare, we must realise that these species are not only excessively threatened by the degradation of their environment, but they are actually symptomatic of that degradation. It is true that there is some direct pressure on the population of these species by hunting, but this pressure is insignificant compared to the large scale destruction of their environment. For conservation purposes it is irrelevant whether this destruction is official or unofficial burning or whether it is burning for afforestation, thatch-mahal or grazing. This is the irony of the situation, for the protective legislation for these animals is only related to hunting, and hunting only exacerbates a situation brought about by burning. Worse, hunting is actually facilitated by the process of burning as we have seen. Present methods of hunting would not be so effective

or even inapplicable in a non-burning situation and the mortality consequent of hunting would be comparatively negligible if the population was not so curtailed by the shortage of unburnt habitat.

Thus we should not just be considering the conservation of hog and hare, but the conservation of the thatch-scrub ecosystem itself. As has been said "faunal conservation depends on habitat conservation" (R. Strahan 1972). This is undoubtedly the most important consideration, for the conservation of pigmy hog and hispid hare in the wild also has implications for a host of other plant and animal species that are an intrinsic part of that ecosystem complex, but of which we have little or no knowledge. Again and again we meet the philosophy in amateur conservation proposals where the recognised dominant species (such as pigmy hog) are considered in terms of particular individual species problems. To consider the conservation of individual species in isolation, is not only putting them out of context it also carries a penalty clause, i.e. the alleviation of a pressure source to conserve a particular environment (and therefore its indigenous species).

Thus all the well intentioned conservation efforts directed towards captive breeding of pigmy hog in Assam, have not only been largely unsuccessful, but they have also ignored the fundamental problems of the wild situation. Captive breeding should not be regarded as a solution for the conservation of pigmy hog. Rather the conservation of pigmy hog should provide a lever for the conservation of the thatch-scrub ecosystem.

This is not to say that captive breeding is not important as it is very important for the reasons outlined in the introduction and must be maintained and improved. However, captive breeding must also be viewed in context and conservation priorities should first and foremost be shifted to positive measures for the protection of their natural environment. Such a policy also has obvious implications for hispid hare for which captive breeding is of very doubtful viability. The husbandry of hares is notorious difficult as already stated, and efforts to maintain this species in captivity have been undertaken with only the flimsiest understanding of their biology. For example, two pairs of hispid hare that were caught for Gauhati Zoo in March 1977 in Manas Sanctuary, all died within a few days of capture. In view of their previous captive record it is doubtful if these would have survived even had they reached their destination and these captures served no useful purpose whatever. It is very unlikely that similar efforts will be any more successful in the future without a much better understanding of their requirements and a specialist knowledge and experience of comparable species (which are more expendable at the individual specimen level).

By contrast, translocation may well be applicable to hispid hare and this technique could well have conservation potential for this species in view of their doubtful future over most of that present range. The same argument applies to pigmy hog in which the translocation attempt at Orang Sanctuary showed promising indications of success, despite the unfortunate choice of local and poor management of the project. Translocation as a technique applicable to these species has been dealt with at length within a separate report (Oliver 1977), but for our purposes here, it is as well to note that as some of the populations also have no future in their present locale, they could well be translocated. Unfortunately burning is so widespread that there is no locality in N. W. Assam that is sufficiently stable for introduction (or preferably

re-introduction) to be warranted, though Sonai-Rupa Sanctuary could well serve this purpose if it were brought up to its nominate status.

Conservation measures must be primarily directed at the protection or salvage of at least some of the small remaining habitation areas of these species. What is really required is a change of attitude about burning and an appreciation of its very serious consequences on natural habitat and resident species. A realisation of the ecological consequences should do much to reduce the present extent of burning. However specific conservation measures are needed and these require prompt and sustained action on the behalf of the authorities. That this action is against the habitual practice of dry season burning and may therefore conflict directly with forestry practices, is a meter of the problems faced. What has been lacking is an understanding of the casual factors in their continuing decline; but it is hoped that we can now demonstrate not only rarity, but also its cause and effect. That the pigmy hog and perhaps even more particularly, the hispid hare, have a precarious future should be in no doubt and they must be regarded as seriously threatened. However an objective analysis of the environmental problems faced by these species (admirably demonstrated by Barnadi) does not lead to optimism with regard to their future. The human responsibility for these species survival must not only be appreciated, but positive action must be taken quickly. If it is not, the empirical reprieve consequent of the reappearance of these presumed extinct species may well prove to be short lived.

Recommendations

A number of suggestions regarding the conservation of these species have been requested by M. A. Islam, Chief Conservator of Forests, Assam, and some of these have already been submitted to the Forest Department. These suggestions, together with further recommendations, are outlined below.

In making proposals, attempts have been made to be as objective and rational as possible about conservation, whilst at the same time acknowledging the primary function of the Reserve Forests as exploitation areas. Therefore whilst a blanket approach to the preservation of all known populations is not feasible and is not envisaged, it is felt that there must be room for compromise even if that conflicts to some degree with the interests of forestry. It must be appreciated that the Reserve Forests are very important distribution areas for these species and that human activities, official and unofficial, in these areas are the main reason for their continuing decline. Their situation is precarious and this is primarily a function of the degradation of their habitat and the conservation of these species therefore depends on the conservation of their habitat.

It is therefore recommended that:—

1. In *Reserve Forests* certain areas known to support these species must be protected from total annual burning. This could be achieved in a number of ways depending on circumstances within each particular forest area, e.g.
   a) Those areas with natural firebreaks such as wet or dry watercourses, or small pockets of thatch-scrub surrounded by forest, should be left unburnt (which generally speaking they are not at the present time), e.g. the eastern side of Khalingdaur Reserve Forest and Naudaur/Balipara Reserve Forests respectively. This should cause no serious problem as there are no forestry operations in these areas apart from the domestic thatch requirements for forest

villagers and officials and these requirements should be met from elsewhere and access to these areas should be restricted, at least during the dry season. Burning for domestic thatch requirements by villagers and forest officials should be prohibited.

b) These Reserve Forests presently supporting populations of these species, but which are subject to total thatch-mahal, should have that mahal concession reduced to clearly defined areas and burning in these areas should be carefully controlled (which generally speaking is uncontrolled at the present time). This way areas could be set aside for these species that should be protected from incidental burning by fireline demarcation. Such areas would have to be at least three or four hundred hectares in extent in order to support viable resident populations. Such an area should be ecologically stable and it would be large enough to be less likely to be totally destroyed in the advent of accidental uncontrolled burning, and less susceptible to present hunting methods.

This may result in the loss of revenue by the reduction of the thatch concession, but these areas could be located where there are established plantations. Areas suitable for protection in this way are the eastern side of Darranga Reserve Forest, parts of Barnadi and Gohpur Reserve Forest (see later text also).

c) Additionally afforestation programmes could be subject to carefully controlled rotational burning so that mature plantations could support thatch-scrub that is left unburnt for several successive years. Early burning of such plantation in plots by demarcation could be rotated so that each plot was burnt not more than every 4 or 5 years so that there was always unburnt displacement habitat available in another adjacent plot.

d) In those Reserve Forests where total thatch-mahal concessions are of small value, e.g. Rowta and Subankhata Reserve Forests, this mahal could be abolished with only small loss of revenue. Such areas are more easily protected from burning and mahal encourages burning and unofficial access to Forest areas.

e) Better efforts should be made to control illegal burning in other areas where there are no mahal concessions and the 'fringe' practices of forest exploitation, e.g. grazing concessions, which represent an unjustifiable risk to habitat in terms of burning, hunting and other disturbances. These aspects should be considered when grazing or settlement rights are granted and preferably such rights should not be granted (or renewed) in areas where these species occur, e.g. Khalingdaur Reserve Forest.

2. In actual *declared wildlife areas* the extent of burning must be severely reduced.

a) At least one other area should be declared a Sanctuary, National Park or Wildlife Reserve for these species in view of the possible, if not probable, restriction to N.W. Assam and the fact that habitat protection measures are legally enforced only in those areas. Suitable areas would be Barnadi or Gohpur Reserve Forest (the latter would be easier to protect from accidental burning) as only these areas are definitely known to support both spe-

cies at the present time.

b) The level of burning must be reduced in Manas (and other Sanctuaries) and controlled burning should be undertaken only for firelines to prevent or reduce the extent of accidental burning. Access by tourists and labourers to some areas should be restricted during the dry season to reduce the risk of accidental burning.

It is felt that most, if not all of these recommendations, could be operated simultaneously as even if a conservation programme in any one area is successfully maintained for several successive years, a single chance fire could quite conceivably exterminate a small population by the total destruction of the available habitat. It is therefore necessary to maintain several populations in these different small areas in order to establish safety margins for the species survival. An additional safety margins for pigmy hog, i.e. captive breeding, must also be maintained and refined with the cooperation and information exchange of all organisations involved in the husbandry of these animals.

Summary

(1) This report is based on a three month field study of pigmy hog and hispid hare that was undertaken in N.W. Assam in March-June 1977. The survey was of admittedly short duration, but in the event its timing proved fortuitous as this dry season period is undoubtedly the most critical time for the biology and conservation of these species. The survey was sponsored by the Assam Valley Wildlife Society and the Wildlife Preservation Trust. I thad the full co-operation and support of the Assam Forest Department.

(2) Since the dramatised re-appearance of these supposedly extinct species in March 1971, there has been much interest in their conservation and there has been a concerted effort to maintain and breed the pigmy hog in captivity, though in retrospect this has not been successful in conservation terms, and anyway it is felt that captive breeding does not represent the solution to the conservation of these species which are much better protected in the wild state. However, the fundamental problems of the wild situation (which are resulting in the continuing decline of these species) have been poorly understood and an objective analysis of these factors has been urgently required.

(3) That these species are declining should be in no doubt as more and yet more of their thatch-scrub habitat is eroded and despoiled by encroachment, or dry season burning and other forestry practices. By the continuing process of settlement of an expanding and immigrating peoples, the natural thatch-scrub savannah habitat of these animals has been reduced to the Reserve Forest belt of N.W. Assam and the Manas Sanctuary. This habitat now forms a series of discrete isolated patches so that their population is subdivided into small units that are highly vulnerable to disturbance. The bulk of this population is in Reserve Forest and the remaining thatch-scrub in these areas is under tremendous exploitation pressure by thatch-mahal, afforestation and grazing. Moreover these areas (and the Manas Sanctuary) are almost universally subject to dry-season burning and burning has been shown to have an ecologically disastrous effect on the habitat of these animals. It is irrelevant whether this burning is the early controlled burning by forestry officials (for forestry purposes) or the later uncontrolled burning by other persons. Virtually all areas are burnt to a greater or lesser degree and these

animals now only occur in small pockets of unburnt thatch-scrub habitat that have been left unburnt, mainly by chance.

(4) There is clearly a direct conflict of interests between forestry and wildlife. As the main distribution areas are the Reserve Forests and these are not wildlife areas they have no real policy for wildlife conservation. These species are declining through habitat destruction, and their habitat is not legally protected in the Reserve Forests and is in fact being systematically destroyed by burning and forestry practices. It is admitted that burning is difficult to control and almost impossible to prevent in some areas, but much burning is deliberate even where there are no forestry operations or even if accidental burning is unlikely. The present level of burning is totally unjustified and the populations of these animals are being unwittingly squandered in the process.

(5) Both species deservedly merit Schedule I categorisation in Indian Wild Life (Protection) Act, 1972, and this Act has recently been ratified by Assam. However, this Act is mainly effective as regards declared wildlife areas and direct hunting pressure. Hunting is a problem in some areas, but is a very small factor compared to the widescale destruction of their habitat and only serves to exacerbate a situation brought about by burning. In fact it has been shown that hunting is actually facilitated by burning. Even in Manas Sanctuary where habitat should be legally protected most of it is being systematically destroyed by controlled burning to prevent uncontrolled burning. It is felt that this Act has little meaning or relevance to the protection of these species over their entire range of distribution.

(6) If the present population/habitat pressures continue as they are very likely to do, it is almost certain that most of these presently known populations will disappear during the next few years. Effective action must be taken quickly by the authorities if the present rate of decline is to be curtailed or even reduced. Suggestions to this effect have been included at the end of the report in the Conclusions and Recommendations sections.

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF THE BOMBAY NATURAL HISTORY SOCIETY—21
Sturnidae

HUMAYUN ABDULALI

[*Continued from Vol. 73*(3):515]

530 specimens of 42 species and subspecies up to No. 1018 in INDIAN HANDBOOK and registered No. 24315 are covered by this part.

984 **Saroglossa spiloptera** (Vigors) (Himalayan Mountains, restricted to Simla-Almora) Spottedwinged Stare **3**:25

29: 16 ♂♂ (1 juv.), 11 ♀♀ (1 juv.), 2 o? juv.

6 Bhagat State, N.W. Himalayas, 3 Lohaghat, Almora; 2 Jalai, Guptakashi, 1 Karuprayag, Garhwal; 4 Dehra Dun; 2 Margherita, 1 Longview T.E., Pankabari, 6 Cachar; 2 *Jade Mines, Tawman;* 1 *Tunkomaw, Prome Dist.;* 1 *Kungawk, Henzada, Burma.*

In both sexes there are some differences in the extent of grey mottling on the head and upperparts, specimens from Dehra Dun and westwards appearing paler than those from Assam and Burma. However, all the pale birds (in worn plumage) are dated between 4 April and 3 July, while the others are 20 Nov. to March, suggesting that the dark birds are all in fresh plumage. Among the males there is considerable variation in the amount of rufous on the underparts.

INDIAN HANDBOOK (5:148) queries the juvenile plumage of the male and female being different. The juvenile ♂ (No. 6612 Dehra Dun 18 June 1910) in which the bill is not yet fully grown agrees with Marien's (1950, *JBNHS* 49:472 *et seq.*) description, except that the streaking on the throat is very restricted possibly due to the manner of skinning. The plumage is generally like that of the adult male but lacks the dark chin and rich rufous of the underparts; the upperparts are as in the adult female but grading into rufous on the lower back and rump. The legs and feet are now paler yellow than in the juvenile females *contra* dark in adults of both sexes.

Specimen 17657 (Bhagat State, 25 June) is marked "Juv. ♀" by A. E. Jones and is similar to two unsexed birds from Lohaghat, Almora, also marked young. They differ from the adult females in being slightly paler all over and with the spotting on the throat and upperbreast replaced by faint streaking. The upperwing coverts have pale edges.

The extent of rufous and white on the underparts varies in different males and the adult plumage is perhaps attained after more than one moult.

Measurements on p. 381.

Though males average slightly larger, the measurements are not exclusive.

985 **Aplonis panayensis affinis** (Blyth) (Tipperah) Tipperah Glossy Stare **3**:24

1 ♀ Rewa Tea Estate, Lakhimpur, S. Sylhet.

Measurements on p. 381.

986 **Aplonis panayensis tytleri** (Hume) (Andamans) Andaman Glossy Stare **3**:23

14: 8 ♂♂ (3 imm.) 5 ♀♀ 1 o?

1 Mannarghat, 1 Wimberleygunj, 1 Maymyo, 1 Long I., 1 South Andamans; 9 Car Nicobar.

Measurements on p. 381 under No. 985/6a.

986a **Aplonis panayensis albiris** Abdulali (Great Nicobar) Great Nicobar Glossy Stare

21: 12 ♂♂ (5 imm.) 9 ♀♀ (6 imm.)

2 Camorta, 10 Nancowry, Central Nicobars; 9 Campbell Bay, Great Nicobar.

In both 986 and 986a, the females in series show less gloss on the underparts. Some of them (♂♂ 23205 Andamans, 22415 Nancowry, 22403 and ♀ 22422 Great Nicobar) have the chin and upper breast almost completely dark.

Measurements on p. 381 under No. 985/6a.

987 **Sturnus malabaricus malabaricus** (Gmelin) (Malabar Coast, as migrant) Greyheaded Myna **3**:39

27: 12 ♂♂ 9 ♀♀ 6 o?

1 Kihim, Kolaba, Maharashtra; 1 Maraiyur, Travancore; 1 Robinson's Park, Madras; 1 Cumbum Valley, 2 Godavary Delta, 1 Sankrametta, Vizagapatam; 1 Barkul, Chilka Lake, 1 Bumt (?), Balasore, Orissa; 1 Rajputtee, Saran, Bihar; 2 Gorakhpur, 1 Ganai, Almora, 3 Naini Tal; 2 Bankulwa Morang, Nepal; 1 Naunati, 24-Parganas, Bengal; 1 Bagho-Bahar, 2 Dibrugarh, 2 Tezu, Lohit Valley, Upper Assam; 1 Lanang, N. Cachar, 1 Dinapur Road, Manipur; 1 *Akyab, Burma.*

Measurements on p. 381.

988 **Sturnus malabaricus blythii** (Jerdon) (Malabar) Whiteheaded Myna **3**:40

26: 15 ♂♂ 10 ♀♀ (3 juv.) 1 o?

1 Ajwa, Baroda, 1 Bulsar; 1 Tulsi, Bombay, 1 Shil, Thana, 4* Ratnagiri; 2 Karwar, 1 Alanki, 1 Santgal, 1 Gundbala, 1 Gotegali, 2 N. Kanara; 1 Telguppa, 1 Lingadelly, Sagar, 1 Jagan Valley, Kadur, 2 Gudalur, Nilgiris, 1 Wynaad, 2 Thekadi, 1 Tenmalai, 1 Kotathrupali, Travancore. (*1 ♂ missing).

Measurements on p. 381 under 987[1].

989 **Sturnus malabaricus nemoricola** (Jerdon) (Thayetmyo, Upper Burma) Whitewinged Myna **3**:42

13: 3 ♂♂ 2 ♀♀ 8 o? (1 juv.)

2 *Kaming, Upper Burma,* 1 *Tounggyi, S. Shan States,* 1 *near Mindon Chaung, Thayetmyo district,* 1 *Kyethe,* 1 *Pakkaing,* 1 *Prome, Prome district,* 4 *Pegu,* 2 *Ataran, Burma.*

Measurements on p. 381 under 987.

990 **Sturnus erythropygius andamanensis** (Tytler) (Andamans) Andaman Whiteheaded Myna **3**:41

4: 2 ♂♂ 2 ♀♀

1 Long Island, 1 Bakultala, Middle Andamans; 1 Wrightmyo, 1 Chirria Tapoo, S. Andamans.

These specimens have been measured and commented upon in my Nicobar paper (*JBNHS 64,* pp. 179-180).

991 **Sturnus erythropygius erythropygius** (Blyth) (Car Nicobar) Nicobar Whiteheaded Myna **3**:41

5: 3 ♂♂ 2 ♀♀ All Car Nicobar

Measurements as under 990.

992 **Sturnus erythropygius katchalensis** (Richmond) (Katchal, Nicobars) Katchal Whiteheaded Myna **3**:42

nil.

993 **Sturnus senex** (Bonaparte) (Ceylon) Ceylon Whiteheaded Myna **3**:46

nil.

994 **Sturnus pagodarum** (Gmelin) (Malabar) Blackheaded or Brahminy Myna **3**:47

36: 20 ♂♂ (2 imm.) 14 ♀♀ (1 imm.) 2 o? (imm.)

5 Chitral, N.W.F.P.; 1 Shikohpur, Jullunder; 3 Bhagat State; 1 Kishtwar, Kashmir; 3 Delhi, 4 Bharatpur; 1 Pali, Jodhpur; 1 Kharirohar, 1 Kuarbet, Kutch; 1 Gir, 1 Nadiad, 1 Dediapada, Rajpipla; 1 Santa Cruz, Bombay, 1 Kihim, Kolaba, 1 Panchgani, 1 Satara, 1 Ratnagiri; 1 N. Kanara; 1 Cassimode, Kerala; 1 Palkonda Hills, 1 Seshachalam Hills; 1 Bulandshar, 1 Bareilli, 1 Kumaon & Naini Tal dist., U.P.; 1 Mowli?

There is considerable variation in the grey of the upperparts and the rufous below; the birds from Chitral Drosh going back to April/May, 1902/3 are the palest above and may be of the pale form *afghanorum* described by

[1] Some notes on this and other subspecies are incorporated in a separate contribution (*in press*).

Koelz. But though in addition, the northern birds measure slightly larger than the southern, the seasonal movements of the species are not yet understood and the material available does not permit any definite opinion.

Measurements on p. 382.

995 **Sturnus sturninus** (Pallas) (Dauria) Dauria Myna **3**:43

1 o? *Pegu, Burma* (C. W. Allan) Wing 110; bill 15.3; tail 52.

996 **Sturnus roseus** (Linnaeus) (Lapland, Switzerland) Rosy Starling **3**:29

55: 36 ♂♂ (5 juv.) 16 ♀♀ (4 juv.) 3 o? (1 juv.)

1 *Felujah, Iraq;* 1 *Kasvin, Persia;* 2 *Kornah* (*Pelar*), 180 m. sw of Kalat, 8 Mastang, 1 Ziarat, Baluchistan; 2 Peshawar, N.W.F.P.; 1 Multan, 1 Pipli, Karnal, Punjab; 3 Delhi, 1 Bharatpur, 1 Bhujia, 1 Kharirohar, 1 Kuarbet, 1 Chotari, Kutch; 1 Radhanpur, 1 Bhavnagar, 1 Nadiad, 1 Vagjipur, 1 Ajwa; 1 Borivli, 3 Santa Cruz, 2 Bandra, 1 Byculla, 1 Bombay, 1 Kaneri I.; 1 Satara; 1 Saugor, M.P.; 1 Karwar; 1 Pt. Calimere, T.N.; 1 Chilka, 1 Attegarh, 1 Tigeria, 2 Khanar, Pal Lohara, Orissa; 2 Baghowni, 1 Jamiya, Darbhanga, Bihar; 1 Kallianpur, Kanpur, U.P.; 3 no data.

The typical pink on the upper back and rump is only visible in specimens taken in June/July/August and then reappears in March/April, those taken in the intermediate period having their backs sullied by the brown tips to the feathers which look very much as if due to staining. According to BRITISH HANDBOOK, 1945, (1, p. 47) this is due to the tips being worn off.

In addition to the difference in size (*q.v.*), the females are duller in colour, and most of them show all-brown feathers on the back, rather than pink with brown tips which hide the pink in the male.

Measurements on p. 382.

EL **Sturnus vulgaris vulgaris** Linnaeus (Sweden) European Starling

22: details below:

(a) 1 o? Isle of Wight, U.K.

(b) 21: 9 ♂♂ 9 ♀♀ 3 o?

1 *Dohuk,* 3 *Bait-u-Khalifa,* 1 *Samara,* 3 *Baghdad,* 1 *The Narrows,* 16 *m. n.e. of Kut,* 2 *Magasin,* 6 *m. e. of Kut,* 2 *Sheikh Saad,* 1 *Felujah,* 1 *Sulaimaniya,* 1 *Amara, Iraq;* 1 *Shustar,* 2 *Katunak,* 8 *m.* and 2 *Pir-e-Banu,* 9 *m. s. of Shiraz, Iran.*

All obtained between 12 November and 11 March.

It must be mentioned at the outset that though the differences among the starlings have been discussed at length, and many subspecies have been described in the Palaearctic, it is impossible to identify all the specimens in widely differing plumages, some of which do not exhibit the characters on which they have been described. The material from Iraq and Iran has been particularly difficult, for in several instances the specimens are marked with one name and referred to in literature by another. Several under (b) above were marked *sophiae* by Ticehurst, who later cut this out and inserted "*vulgaris*" and in his subsequent reports (*JBNHS 26*: 382 and *28*: 275) does not think them separable. The original description of *sophiae* refers to a purple head and a green eye patch. Of the 35 skins of 4 subspecies examined by Ticehurst, 25 are now available. All mentioned under (b) have purplish heads *contra* greenish in the single specimen under (a), and may well be included with *poltaratskyi* below.

The spotting in several is also much more prominent and displays a more whitish bird than in any other race, or exhibited in any of the coloured illustrations available of the nominate race. The identifying characters (or the differences) are mentioned in brief but it is not possible to be very certain of some of the identifications.

Measurements on p. 384.

EL **Sturnus vulgaris caucasicus** Lorenz (Northern Caucasus) Caucasian Starling

4: 1 ♂ (juv.) 2 ♀♀ 1 o? (juv.)

1 *Amara, Iraq;* 1 *Meshed, N. Persia;* 1 *Kangwai, Iran;* 1 *Mishun, Persian Gulf.*

Adult female 6669 (Meshed, 23 February) has the head and ear-coverts greenish and the rest of the upperparts similar to those of *nobilior*. This appears to be a resident form in Iran and the two juveniles are included herein. The other ♀ No. 6682 from Amara, Iraq, was collected by R.E. Cheesman on 4 February, 1918 and though marked *caucasicus* by Ticehurst, the head is purple and only the ear-coverts slightly green (?). In the absence of any alternative, it is left here.

No. 6683 from Kangwai is the all-brown fledgling with a white chin and more white in the centre of the lower belly, as illustrated in European ornithological literature. The other is older and dark sooty all over spotted (except head and throat) buff above and white below, with the spots on the lower breast and belly being larger. The primary coverts are edged with rufous.

Measurements on p. 384.

997 **Sturnus vulgaris poltaratskyi** Finsch (Marka-Kul, Eastern Kazakhstan) Common Indian Starling **3:**34

40: 16 ♂♂ (1 juv.) 20 ♀♀ (1 juv.) 4 o?

1 *Mishin, Persian Gulf*; 1 Wana, Waziristan; 1 Peshawar; 2 Kesun 4500′, Chitral; 1 Campbellpur, 2 Rawalpindi, 1 Mianwali, 2 Jhelum, 1 Madhopur, 2 Shikohpur, Jullunder, 1 Chandigar, 2 Darazpur, 2 Ambala, 1 Dankuri, Karnal, 1 Mubarakpur, 1 Bahawalpur; 1 Bhagat State, Simla; 2 Delhi; 1 Shah Hasan, Manchar, Sind; 3 Santanwara, 1 Gwalior; 2 Sait, Kaira, 2 Rewana Tank, Jasdan; 4 Rewas, Kolaba, Maharashtra; 1 Tirhut, 1 Baghowni, Bihar.

The amount of purple following that of the head along the back varies to an appreciable extent; birds with spotted heads, November to January, appear to show less purple and more green.

Two from Jhelum (20 March 1897) have dusky heads with no gloss and appear juveniles and their 125 and 127 mm wings appear too large to belong to *indicus*.

Measurements on p. 384.

998 **Sturnus vulgaris nobilior** Hume (Kandahar) Afghan Starling **3:**34

7: 2♂♂ 3 ♀♀ 2 o?

2 *Sheikh Saad, Iraq;* 1 *Sitarbo,* 21 *m. s.e. of Khwash, Persian Baluchistan;* 1 Wano, Waziristan; 1 Chaman, Baluchistan; 1 Mianwali, Punjab; 1 Parjah, Bettial, Champaran, Bihar (?)

As in *poltaratskyi,* there is a purple head followed by green but both colours are brighter and the wing-coverts purple and not green. The spots on the upperparts are also white *contra* buff, smaller and less abundant and the under wing-coverts are darker with narrow white edges to each feather.

Hume described this with great enthusiasm but subsequent workers do not appear to have agreed. The male and female from Sheikh Saad have large 135 mm wings and of which the former (No. 6679) was named *caucasicus* by Ticehurst (loc. cit) though the label reads *nobilior*. All the other five of both sexes have their wings under 130 (125-129). Unsexed Sp. No. 6692 from Chaman, Baluchistan, is in the spotted phase but it has a purple head, green back spotted with white (?) and a little purple on the wing-coverts.

Sp. No. 6713 is marked as Parjah, Bettial and said to have been collected by F.J.R. Field on 16-2-1892. A Mr. Frank Field is included in the list of members of the Society for 1892, from Behar. If the place name is read as Bettiah in Bihar, and the identification is correct, this is a considerable extension of its presently accepted range.

Measurements on p. 384.

999 **Sturnus vulgaris porphyronotus** Sharpe (Yarkand) Central Asian Sarling **3:**32

10: 5 ♂♂ 3 ♀♀ 2 o?

2 Kiba Drosh, 2 Jinjoret, Chitral; 1 Campbellpur, 1 Jagadhri, 1 Madhopur, 2 Ambala; 1 Baghowni, Bihar.

These are distinguished by the greenish head followed by the all purple upperparts, including upper wing-coverts. The Baghowni specimen if correctly named extends the recorded distribution of the subspecies.

Measurements on p. 384.

1000 **Sturnus vulgaris minor** Hume (Larkana, Sind) Sind Starling **3:**33

2 ♀♀

1 Dalipata, Hyderabad, 1 Audalbad, Sukkur, Sind.

Both (3rd March and 12th April) are in dark plumage and have yellow bills. The same remarks apply to all dated specimens (8) under 1001 *indicus* below, and which were obtained between 3rd March and 17th May. Ticehurst (*Ibis* 1922, p. 622) states that the winter spotting and the juvenile plumage are much the same as in the typical race.

Measurements on p. 384.

1001 **Sturnus vulgaris indicus** Blyth (Nepal) Kashmir Starling **3:**31

10: 5 ♂♂ 3 ♀♀ 2 o?

2 Kupwara Road, 2 Srinagar, 2 Kashmir Valley, 4 Kashmir.

See remarks under 1000 above. No. 20607 (17th May) is sooty all over, with almost no gloss, presumably juvenile.

All the specimens have a greenish tinge on the ear-coverts.

Measurements on p. 384.

1002 **Sturnus contra contra** Linnaeus (Chandernagore, Hooghly District, W. Bengal) Indian Pied Myna **3:**63

25: 16 ♂♂ 8 ♀♀ 1 o? imm.

2 Jagadhri, Ambala; 3 Bharatpur, Rajasthan; 1 Trombay, 1 Malad, Bombay; 3 Saugor, 1 Jubbulpore, 3 Geedam, Bastar, M.P.; 1 Nelipaka, Hyderabad, 1 Parvatipur, Vizagapatam; 1 Nilgiri, 2 Barkul, Chilka Lake, Orissa; 1 Baghowni, 1 Manjhaul, Bihar; 2 Meerut, 1 Manhofe, Terai, 1 Nawepur, Nepal.

The upperparts of the females are browner than in the males.

The immature bird has a brown head contrasting with the already black feathers of the back and wings.

Measurements on p. 382.

1003 **Sturnus contra sordidus** Ripley (Sadiya, Northeastern Assam, Lohit Division, NEFA) Eastern Pied Myna

7: 2 ♂♂ 2 ♀♀ (1 juv.) 3 o?

1 Sadiya, 1 Tez, Lohit Valley; 2 Dibrugarh, Assam; 3 *Upper Burma.*

The two males from Sadiya and Lohit Valley are distinctly greyer below and have sepia-coloured (not whitish) streaks on the shoulders. Nominate *contra* do not show streaks on the nape as stated in the key in IND. HANDBOOK.

The female from Dibrugarh is not so distinctly different as the male and the three unsexed birds from Upper Burma though not separable from nominate *contra* are left here (?).

The juvenile has a brown head slightly darker than the back.

Measurements on p. 382.

1004 **Sturnus contra superciliaris** (Blyth) (Rangoon) **3:**64

2 ♀♀

1 *Hkamti, Myitkyina District, Upper Burma;* 1 *Henzada, Burma.*

In both birds the back is very brown *contra* black head.

Measurements on p. 382.

1005 **Sturnus sinensis** (Gmelin) (China) Chinese or Greybacked Myna **3:**37

nil.

1006 **Acridotheres tristis tristis** (Linnaeus) (Pondicherry) Indian Myna **3:**53

51: 21♂♂ 26♀♀ (1 juv. 2 albinoid) 4 o? (1 juv.)

1 Ornach, Baluchistan; 1 Miranshah, N. Waziristan; 1 Chitral Drosh, 1 Pandach Valley, 1 Srinagar, 1 Kashmir Valley, 1 Lalroo, 2 Ambala; 6 Simla;

2 Bharatpur; 2 Kharirohar, Kutch; 1 Amreli, Gir, 1 Bodeli, Baroda; 1 Bhiwandi, 1 Mumbra, Thana, 1 Mulund, 1 Andheri, 1 Bandra, Bombay; 1 Konkan; 1 Karwar; 1 Cassimode, 1 Aramboli, 1 Trivandrum Beach; 1 Bhadrapur, 1 Talguppa, 3 Anandpurna, Sagar, Mysore; 1 Chitteri Range; 1 Nallamalai Range; 1 Rajputtee, Saran, 1 Bhagowni, 1 Manjhaul, 1 Bairia, Patharghatta, Bihar; 1 Chamoli, Gharwal, 1 Rampur, 2 Kurseong; 1 Dibrugarh, 1 Goalpara, 2 Sadiya, Assam; 1 Wrightmyo, Andamans.

There is appreciable variation in the depth of the brown both above and below, and in the measurements, including the length and thickness of the bill, but it is not possible to localise any of these differences. The darkest birds from Kerala can be matched with specimens from Simla, but all the several specimens with paler underparts appear to be from the north and northwest, i.e. 1 Chitral, 2 Kharirohar, Kutch, 1 Bodeli, Baroda, 2 Bombay area. A ♂ No. 6834 from Aramboli, S. Travancore has the black of the neck and breast extending towards the abdomen in the centre grading towards *melanosternus* of Ceylon, as suggested by Vaurie (1959).

I recently (Oct. 1975) assisted Dr. A. J. Baker from Royal Ontario Museum in collecting a series of 20 males and 16 females around Bombay and the measurements of these birds are mentioned separately. The single ♀ from Wrightmyo, Andamans, where it was introduced in the 1850s, is the smallest. Though no separate subspecies is now accepted from Burma, it may be worth recalling that in *Ibis* 1868, p. 220 Blyth is quoted as referring to specimens from Port Blair, Andamans, being smaller and darker than those from Bengal and resembling those from Burma. The birds are said to have been introduced in the Andamans by Col. Tytler.

The collection includes two almost pure white specimens from Ambala, Punjab and Rajputtee, Saran, Bihar. No. 17697 from Simla is pale brown all over with the head slightly darker, but not black. No. 6826 from Miranshah, N. Waziristan is pale fawnish all over, with the head slightly darker, and whiter wings and tail. No. 17699 juv. ♀. Simla is dull brown with wings and tail largely white; the white stripes over the eyes meet at the nape, which is black as also the cheeks, creating a very distinctive effect.

After completion of these notes I saw R. K. Brooke's MORPHOLOGICAL NOTES ON *Acridotheres tristis* IN NATAL [*Bull. B.O.C.* 1976: 96 (1), pp. 8-13] in which he revives Hodgson's *Maina tristoides* (1836) holding that birds from peninsular India are paler and duller below and less reddish on the back than birds from Burma and Nepal. The differences are expressed in Ridgway's (1912) colours. We have no material from Nepal or Burma, but the variations in colour visible in the specimens available do not appear to support any definite colour change in that direction.

Measurements on p. 382.

1007 **Acridotheres tristis melanosternus** Legge (Pasdun Korale, Ceylon) Ceylon Myna **3:55**

1 ♀ Pasvala, W.P., Ceylon.

Measurements on p. 382.

1008 **Acridotheres ginginianus** (Latham) (Gingee) Bank Myna **3:55**

9: 4 ♂♂ (2 juv.) 4 ♀♀ 1 o?

1 Shikohpur, Jullunder, 1 Jagadhri, Ambala; 1 Delhi; 1 Kutch, 1 Ajwa, Baroda; 1 Ghoti, Nasik; 1 Saugar, M.P.; 1 Baghowni, Tirhut, Bihar; 1 Bulandshar, U.P.

There is some variation in the tone of grey on the upperparts but the number available is insufficient to warrant any remarks. The juvenile male from Baghowni, Bihar (24 Novvember) has its head a paler brown than in the other from Ajwa, (2 November Baroda) and which is generally browner on the back

and wings. Both have whitish chins which immediately separate them from the adults.

Measurements on p. 383.

1009 **Acridotheres fuscus fuscus** (Wagler) (Sikkim) Northern Jungle Myna **3**:57

13: 6 ♂♂ 7 ♀♀.

1 Rawalpindi, Punjab; 2 Solon, Simla Hills; 2 Supkar, Balaghat, M.P.; 1 Tigeria, 1 Beriberi, Puri, Orissa; 2 Baghowni, 1 Madhubani, Bihar; 1 Mussoorie, U.P.; 2 Calcutta Market.

All three races have been arranged largely on the basis of the distribution in INDIAN HANDBOOK, but none of them appear to be very easily separable. Except for two from Tigeria, Orissa and Mussoorie, all the above have paler underparts which are more distinctive than any other character.

Measurements on p. 383.

1010 **Acridotheres fuscus mahrattensis** (Sykes) [the Ghats (near Poona)] Southern Jungle Myna **3**:57

15: details below.

(a) 6: 4♂♂ 2 ♀♀

1 Raita, Kalyan; 1 Kihim, Alibag, Kolaba; 4 Ratnagiri.

(b) 9: 6♂♂ 3 o?

1 Karwar, N. Kanara; 2 Hirebhaskar, 1 Lingadhally, Sagar, Mysore; 4 Shembaganur, Palnis; 1 Travancore.

Birds in group (a) are slightly paler, both above and below, than those from North Kanara and southwards, some of the latter being barely separable from *fumidus,* except for the browner upperparts of the former.

Measurements on p. 383.

1011 **Acridotheres fuscus fumidus** Ripley (Sadiya, N.E. Assam) Eastern Jungle Myna

9: details below.

(a) 3♂♂ 4♀♀ (2 juv.)

1 Goalpara, 1 Sadiya, 1 Tezu, Lohit Valley; 2 Margherita, Dibrugarh, 1 Assam, 1 *Upper Burma.*

(b) 1♂ 1 ♀

1 *Prome,* 1 *Ataran, Amherst, Burma.*

Wing ♂ 122, ♀ 121

The specimens date back to 1913 and 1929 but compared with older specimens under (a), show more brown tending towards *mahrattensis.*

Measurements on p. 383.

1012 **Acridotheres javanicus infuscatus** (Baker) (Lower Chindwin, Burma) Orange-billed Jungle Myna **3**:59

3: 1♂ 2 o?

1 *Myitkyina,* 1 *N. Shan State,* 1 *Yawmyo, Pakkoku, Magye district, Burma.*

These were listed under *A. fuscus,* but lack the dark patch (blue in life?) at the base of the bill, are darker both above and below and also larger than the nearest race of *fuscus* i.e. *fumidus* (No. 1011 above).

Measurements on p. 383.

1013 **Acridotheres albocinctus:** Godwin-Austen & Walden. (Manipur Valley). Collared Myna **3**:60

3: 2♂♂ 1 o?

1 Moirang, Manipur; 1 *Kamaing, Myitkyina,* 1 *Maymyo, Burma.*

The smaller male (also the unsexed bird) is browner above and duller below than the larger.

Measurements on p. 383.

1014 **Mino coronatus** (Blyth) (Tenasserim) Goldcrested Myna **3**:44

nil.

EL **Sturnus cineraceus** Temminck (Japan) Grey Starling

1 o? *Kamaing, Myitkyina, Burma* (H. H. Harrington 10 Feb. 1901).

Wing 131 (122-132), bill — (23-25); tail 64 (61-65).

EL **Sturnus burmannicus burmannicus** (Jerdon) (Thayetmyo, Upper Burma) Vinous-breasted Starling **3**:50

7: 2♂♂ 3♀♀ 2 o? (1 juv.)

2 *Shwebo,* 1 *Pakokku,* 2 *Prome,* 2 o?

Unsexed Sp. No. 23977 with no data, has the white head and throat of the adult replaced

by a rufous which suggests a stain but is said to be the plumage of the juvenile. Its bill however is noticeably longer than in the others —23.5 mm *cf.* 19.5-21.8 av. 21.

The two without data, viz. one with the longer bill, and the other collected by J.P. Cook, both have their underparts slightly darker than in the others.

EL **Sturnus nigricollis** (Paykull) (Canton, China) Blacknecked Myna **3:**49

4: 1♂* 2♀♀ 1 o? (juv.)

1 *Shwebo,* 2 *Maymyo;* 1 *Nangpens, N. Shan States.*

Wing 153, 157 *158 (150-159); bill 27.5, 28.6, 29.5* (29-30); tail 83, 89, *92 (87-91).

1015 **Gracula religiosa intermedia** A. Hay (Cachar) Northern Hill Myna **3:**19

9: 3 ♂♂ (1 juv.) 4 ♀♀ 2 o?

2 Bankulwa, Morang, Nepal; 1 Berrik, 600′, Sikkim; 1 Margherita, Assam; 1 *Wuntbo district,* 1 *Thayetmyo,* 1 *Ataran,* 1 (?) *Burma;* 20 m west of *Meetaw,* 1 *Siam.*

See remarks under 1017.

Measurements on p. 384.

1016 **Gracula religiosa indica** (Cuvier) (S. India) Southern Hill Myna **3:**17

17: 8♂♂ 6 ♀♀ 3 o?

1 Kumta, 2 Patoli, 2 N. Kanara; 1 Gamorthaghatta, 1 Lingadhally, Sagar, Shimoga district, Karnataka; 1 Kallar, 2500′, 1 Honametti, 1 Gudalur, 5000′, 2 Wynaad, Nilgiris; 3 Shambaganur, Palnis, 1 Thekaddy, 1 Balamore, Ashambu Hills, Travancore.

Measurements on p. 384.

1017 **Gracula religiosa peninsularis** Whistler & Kinnear (Sambalpur, Orissa) Eastern Hill Myna

4: 1 ♂ 3 ♀♀

1 Bastar; 1 Gomia, 1 Kutri, Daspalla, Orissa; 1 Bihar.

Some time back, at the instance of Dr. Ripley I had a look at these specimens and was unable to separate them from *intermedia* (No. 1015) above. As will be seen from the measurements on page 384 they are not separable by size and do not differ in having a "finer" bill. The 4 specimens could be picked out by their "higher" and apparently shorter bills, but this impression is not substantiated by the measurements as taken.

1018 **Gracula religiosa andamanensis** (Beavan) (Andaman) Andaman Hill Myna **3:**20

1: 4♂♂ 3 ♀♀

2 Betapur, M. Andamans; 1 Wrightmyo, 1 Chauldhari, 1 Port Blair; 2 Narcondam Island.

Measurements on p. 384.

See remarks (1976) *JBNHS 71*: 502 re. Narcondam specimens.

1018a **Gracula religiosa halibrecta** Oberholser (Little Nicobar Island) Nicobar Hill Myna

7: details below.

(a) 4: 2♂♂ 2♀♀ Great Nicobar

(b) 3: 1♂ 2♀♀ Central Nicobars.

1 Camorta, 1 Dening, 1 Nancowry.

In 1967 (*JBNHS 64*: 180-1) I accepted this race for its larger size and the lappets on the back of the head "being joined and bearing no feathered portion in between". This could perhaps be better expressed by saying that the *joint* of the lappets is some distance away from, and free of the feathered portion of the head *contra* flush with, and sometimes hidden by the feathers.

Specimens in Group (b) from Central Nicobars do not show this character and are larger than birds from the Andamans, approaching the two from Narcondam Island (see under 1018). Stuart Baker in FAUNA (*3*:20) refers to two specimens from South Andamans, in the British Museum, having very strong, coarse bills and being much nearer to *G. r. javana.* Without any material from Java and considering the curious fact that the species has not been recorded from Car Nicobar, no further remarks are possible.

Measurements on p. 384.

984 **Saroglossa spiloptera**

	Wing	Bill	Tail
Western ♂♂	109-114 av. 110	17·5-20.1 av. 19·3	55-60 av. 57·8
Eastern ♂♂	107-113 av. 109·5	17·9-19·3 av. 16·3	55-62 av. 58.5
(IH *ex* Marien	110-115	--	56-61)
Western ♀♀	101-112 av. 105·4	18.2-20·4 av, 19·3	54-61 av. 56
Eastern ♀♀	103-108 av. 105·6	18.2-19·2 av. 18·6	50-62 av. 56·6
	(IH *ex* Marien 105-106		54-58)

985/6a **Aplonis panayensis affinis, A. p. tytleri, A. p. albiris**

	Wing	Bill from feathers	Bill from nostril	Tail
A.p. tytleri ♂♂	118-120 av. 118·4	19-21·4 av. 19·9	14·4-15·6 av. 14.9	70-78 av. 74.2
A.p. tytleri ♂♂ (imm.)	109,117,117	17,18·7,19	13·4,14,14·7	67,71,71
A.p. albiris ♂♂	115-121 av. 119	17·5-20·5 av. 18·8	13·5-15·6 av 14·1	71-76 av. 73·3
A.p. albiris ♂♂ (imm.)	109-121 av. 114	18·6-19·7 av. 19	13·5-15·2 av. 14·5	67-69 av. 67.4
A.p. affinis 1 ♀	110	17·2	13.2	70
(IH *ex* Ticehurst ♂♀	106-113	–	–	–)
A.p. tytleri ♀♀	111-116 av. 113	18·19 av. 18·7	13·5-15·2 av. 14·3	67-70 av. 69
A.p. albiris ♀♀	112,115,116	18,18.2,19.3	14,14·2,15	67,71,71
A.p. albiris ♀♀ (imm.)	103-108 av. 106	17·6-19·3 av. 18·1	13·5-15·2 av. 14·3	63-68 av. 64·5
	(♂♀ 112-120	–	–	–)

987/9 **Sturnus malabaricus malabaricus, S. m. blythii** and **S. m. nemoricola**

	Wing	Bill	Tail
♂♂			
nominate northern (6)	100-102 av. 101*	17·5-18·7 av. 18	61-64 av. 62·5
,, southern (5)	101-103 av. 102	18·2–19·7 av. 18·5	61-65 av. 61·4
	(IH 98-106	from skull 21-24	59-65)
blythii (12)	102-106 av. 104	19-21.8 av. 20.2	60-67 av. 63·5
	(IH 96-107	from skull 23-24	62-67)
nemoricola (7)	98-103 av. 101.5	16-20	59-66 av. 62
	(94-103	–	–)
♀♀			
nominate northern (4)	97·104* av. 100	17-19·5 av. 18·8	56,57,60,65*
,, southern	96,97,99	17,18,18.5	55,60,60
	(IH 94-104	from skull 20-22	55-65)
blythii	100-104 av. 102·5	18·4-20 av. 19·3	60-64 av. 61·4
	(IH 97-104	from skull 22-25	59-65)
nemoricola (5)	95-99 av.96·3	16-17.2	57-61 av. 59·5
	(IH ♂♀ 94-103	–	–)

* The large male No. 6751 from Dibrugarh, referred to in the text is not included but females include No. 6771 from Tezu with the largest wing* and tail.*

994 **Sturnus pagodarum** (Gmelin)

		Wing	Bill	Bill from nostril	Tail
Northern ♂♂	(11)	104-112 av. 109.8	17-20·2 (18·1)	13·5-15.3 av. 14·2	65-71 av. 67·3
Southern ♂♂	(5)	102-104 av. 103.4	16.9-19·5 (18)	14·2-15.7 av. 14·7	62-66 av. 63·4
		(IH 99-112	from skull 20-24	–	60-75)
Northern ♀♀	(7)	101-108 av. 106	18-20 (18·6)	13·5-15 av. 14.3	61-69 av. 65
Southern ♀♀	(6)	100-105 av. 102·6	16.6-17.5 (17·1)	12·1-15·1 av. 13.6	59-65 av. 63
		(IH 99-109	from skull 20-21	-	58-68)

996 **Sturnus roseus** (Linnaeus)

Wing	Bill	Tail
♂♂ 127-138 av. 132·4	20-22.6 av. 20·7	62-76 av. 69·7
(IH 125-136	from skull 24-26	67-73)
♀♀ 123-131 av. 126	19·3-23·5 av. 21·5	61-68 av. 64.7
(IH 122-126	from skull 22-24	65-72)

1002-4 **Sturnus contra** subspp.

♂♂	Wing	Bill	Tarsus	Tail
S. c. contra	117-125 av. 121	28.4-30·5 av. 29·3	30-32 av. 31·3	64-72 av. 67·4
	(IH 118-126	from skull 30-35	32-35	63-75)
S. c. sordidus	118, 121	31 (2)	29,32	67
	(IH 116, 124	from skull 33, 35	-	-)
♀♀				
S. c. contra	110-123 av. 118.6	27·3-30 av. 28.8	28-34 av. 31	62-72 av. 66
	(IH 114-120	from skull 31-33	32-34	64-72)
S. c. sordidus	120	31·5	32	65
S. c. superciliaris	114 (2)	29·2, 30·6	28,30	62,67

1006-7 **Acridotheres tristis** subspp.

♂♂	Wing	Bill	Tarsus	Tail
A. t. tristis	139-153 av. 146·5	20·3-22·7 av. 21.4	34-43 av. 38·5	81-91 av. 87·3
Bombay (AJB)	138-147 av. 144·5	20·2-24·3 av. 22·1	—	83-96 av. 87.5
	(IH 138-153	from skull 25-30	34-42	79-86)
♀♀	133-150 av. 141·5	20-24·4 av. 22·4	35-41 av. 38	72-96 av.82.3)
1 Andaman	130	21	36	72
Bombay (AJB)	134-144 av. 139	19·4-23·9 av. 21.4	-	73-90 av. 85
	(IH 138-147	from skull 25-28	35-41	79-86)
Dr. Baker weighed his specimens ♂♂ 112-150 gm av. 132·5gm ♀♀ 99-141gm av.120 gm				
melanosternus	133	18.7	32	72

1008 **Acridotheres ginginianus**

	Wing	Bill	Tarsus	Tail
♂♂ (2)	117, 119	19.5 (2)	-	62, 64
	(IH 118-129	from skull 24-25	-	65-74)
♀♀	120-124	19·5-21·3	-	65-73
	(IH 114-123	from skull 24	-	60-71)

1009-11 **Acridotheres fuscus** subspp.

♂♂		Wing	Bill	Tarsus	Tail
A. f. fuscus		120-131 av. 125.6	19·5-22·5	30·35 av. 32·7	70-73 av. 71
		(IH 122-130	from skull 26-28	-	72-76)
A. f. mahrattensis (a)		120-129 av. 125	20-20·2 av. 20·1	30-32 av. 31.5	69-75 av. 73·2
A. f. mahrattensis (b)		122-132 av. 126·8	20-21·2 av. 20·5	30-32 av. 31.5	69-82 av. 74.3
		(IH 126-134	from skull 26-28	*c.* 36	73-79)
A. f. fumidus	(a)	118, 123 (2)	21.3, 21·6	32, 34, 35	72, 74, 75
		(IH 4♂♂ 120-128	-	-	-)
	(b)	122	21·7	32	63 (worn)
♀♀					
A. f. fuscus		115-126 av. 120	19·5-21·2 av. 20·5	31-35 av, 32·7	67-73 av. 70
		(IH 120-125	from skull 25-27	-	67-75)
A. f. mahrattensis (a)		121, 130	19·5, 20	32 (2)	72, -
		(IH 121-131	from skull 25-27	*c.* 36	70-78)
A. f. fumidus	(a)	124, 127	21·7,22·6	34 (2)	71, 75
	(b)	121	21	33	69

1012 **Acridotheres javanicus infuscatus**

	Wing	Bill	Tarsus	Tail
1 ♂ 2o?	137, 139, 144	21·4, 23, 23·6	36, 36.4, 37·4	73, 81,81
	(IH 120-130	22-23	37-43	77-88)

1013 **Acridotheres albocinctus**

	Wing	Bill	Tarsus	Tail
2 ♂♂ 1o?	135, 135, 131*	22·7, 23·5, 24*	33·5, 36·5, 34·3	72, 83,73*

1015-18a **Gracula religiosa** subspp.

♂♂	Wing	Bill	Tail
G. r. intermedia	167, 170, 171	25·7, 26·5	70, 80
	(IH 166-176	from skull 31-32	75-85)
G. r. peninsularis	166	-	79)
	(IH ♂♀ 150-165	from skull 29-31	72-74)
G. r. indica	138-146, 156, av. 144·3	23-26·5 av. 25	62-74 av. 66·5
	(IH 139-155	from skull 29-32	55-72)
G. r. andamanensis	168 (2)-175 (2)	28·5, 28·6, 29·1, 30 (2)	71, 82-85
Central Nicobars	180	av. 29.2 30	87
G. r. halibrecta	171, 180, 182, 185	25·7, 20·5, 30, 30·4	86, 89 (2), 85
♀♀			
G. r. intermedia	160, 164, 165, 170	24·5, 25·5, 25·5	71, 77, 79, 81
	(IH 163-169	from skull 31-33	80-84)
G. r. peninsularis	155, 164, 166	26·8, 26·7 (2)	72, 73, 74
	(IH ♂♀ 158-165	from skull 29-31	72-74)
G. r. indica	136-149, av. 142	24-26·5 av, 24·8	60-66 av, 62
	(IH 140-149	from skull 29-31	60-70)
G. r. andamanensis	163, 169, 170	28·5, 29, 30·5	78, 80, 86
Central Nicobars	170, 172	28·4, 29·2	78, 80
G. r, halibrecta	175, 180	29	84,88

Sturnus vulgaris subspp.

	Wing	Bill	Tail
1 o? nominate *vulgaris*	137	27·2	64
	(Br. Handbook ♂♀122-132	from skull ♂ 25-27 (one 28)	♂ 64-68)
♂♂ "*sophiae*" ?	130-136 av. 133·1	25·3-28.8 av. 27·1	61-65 av. 62.5
♀♀ "*sophiae*"	127-135 av. 130·6	25.9-28.5 av. 27	59-65 av. 61.4
♂♂ *poltaratskyi*	127-136 av. 131·3	24·5-27·6 av. 26.4	59-66 av. 63
	(IH *ex* HW 125–135	from skull 28-32	62-69)
♀♀ *poltaratskyi*	125-134 av. 129	23·5-28·7 av. 26·6	57-65 av. 61·3
	(IH *ex* HW 124-131	from skull 28-37	59-65)
♂♂ *nobilior*	128, 135	28·5, 29·2	64 (2)
	(IH -	from skull 31-34	-)
♀♀ *nobilior*	125, 128, 135	28·5, 29	61,65
	(IH 127-134	from skull 31-34	-)
♀♀ *caucasicus*	127, 128	26·6, 27·7	63, 65
♂♂ *porphyronotus*	130-134 av. 132	26·2-30 av. 28	63-64
	(IH 129-137	from skull 32-34	62-69)
♀♀ *porphyronotus*	126, 128, 129	26·6, 28, 28·2	59, 62
	(IH 122-129	from skull 31-34	62-66)
♀♀ *minor*	111, 114	26, 26·1	55, 56
	(IH 110-120	26-27	-)
♂♀ *indicus*	113-121	25-27·5	50-55
	(IH 113-121	from skull 28-32	54-59)

(to be continued)

SWARMING BEHAVIOUR IN NATURE AND COLONY FORMATION UNDER LABORATORY CONDITIONS IN *ODONTOTERMES MICRODENTATUS* ROONWAL & SEN-SARMA AND *ODONTOTERMES OBESUS* (RAMBUR) (ISOPTERA: TERMITIDAE)[1]

V. B. AGARWAL[2]

INTRODUCTION

Swarming behaviour and colony foundation in primitive termites have been studied in detail by Pickins (1934), Buchli (1950), Herfs (1951), Lüscher (1951), Roonwal & Sen-Sarma (1955), Weesner (1956), Wilkinson (1962) and Nutting (1965, 1966) and on higher termites some observations have been recorded by Williams (1959), Arora & Gilotra (1959), Sen-Sarma (1962) and Sands (1965). However, besides those of Arora & Gilotra (1959) and Sen-Sarma (1959), no other study seems to exist in the literature on the nuptial flight and colony foundation in the higher fungus growing termites of India. The present study was taken up in order to fill up this lacuna.

MATERIAL AND METHODS

For field studies wire mesh tents were put up for two years covering five mounds of *O. microdentatus* and five mounds of *O. obesus* every year in the month of January and February. The wire mesh tents did not interfere with either ventilation or wetting of the mounds during the rains, thus maintaining the normal natural conditions. After the start of monsoon rains, observations were taken daily in order to note the actual swarming date.

OBSERVATION AND DISCUSSION

In Dehradun, swarming of both species was noticed inside the wire mesh tents in the third week of June (17th) at 23 hr in 1973 and in the fourth week of June (26th) at 5 hr in 1974, which coincided with the date and time of swarming that took place in other uncovered mounds existing in the vicinity. The swarming was preceded by a good shower of rain and continued for six hours in 1973 while in 1974 it was not preceded by rain but at the time of swarming, the sky was overcast with dark clouds and the light was dull. The air temperature and the relative humidity at the time of swarming ranged from 24.2 to 24.9°C and 95% r.h. in 1973 and 20.9 to 21.8°C and 80% r.h. in 1974 which may provide major stimulus for initiating the flight period (Nutting 1965). For purpose of swarming only a few (4-8) vents were made by the workers mostly on the top of the mound connecting it to a wider chamber (Probably acting as the launching platform) in *O. microdentatus*. In

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case of *O. obesus,* the vents were made in the hollow shafts of the mound. No holes on the ground as reported by Mathur & Sen-Sarma (1962) in *O. obesus* were observed in either *O. microdentatus* or in *O. obesus.*

No fixed time for swarming as reported by Harris (1958) in *O. badius* (one hour after sunset) and Sen-Sarma (1962) in *O. assmuthi* (at 4.30 p.m.) was observed. Only a single swarm was observed in a year. Single swarming in a year has also been recorded in *O. obesus* (Annandale 1923, Beeson 1941, Arora & Gilotra 1959, Mathur & Sen-Sarma 1962 and Roonwal 1970) and in *O. assmuthi* (Sen-Sarma 1962). This is in contrast to the swarming habits of the primitive termites where two or more swarming per year have been recorded (Herfs 1951, Roonwal & Sen-Sarma 1955, Harris 1950 and Nutting 1965, 1966). The swarming of few alates at a time in primitive termites has the advantage of reducing the chances of predation. This is necessary as the population in these termitaries is comparatively lower than in the termitaries belonging to *Odontotermes.*

The alates were collected from wire mesh tents as well as at light. Each sample comprised of about 200 alates. On an average, the male-female proportion in samples collected from wire mesh tents was 21.2% and 78.8% in *O. microdentatus,* and 28.1% and 71.9% in *O. obesus.* In the samples collected from light, the average male: female proportion was 22.1% and 77.9% in *O. microdentatus,* and 25.5% and 74.5% in *O. obesus.* Sands (1965) in five species of *Trinervitermes* also observed that in swarms, females were predominant in number over the males. However, an extreme case of male predominance was reported by Uchanco (1919) in *Microtermes gilvus philippinensis* (95% and 5% in the swarm). Thus it is significant to note that male:female do not exhibit the typical 1:1 ratio.

Dealation: The process of dealation was studied in the fields as well as in the laboratory. The alates after the dispersal flight settled down on the ground or bushes and cast off their wings by raising the abdomen frequently and rubbing it against rough surfaces which causes breaking of the wings at the basal suture.

In the laboratory more than 100 alates of each species mostly with wings intact, were kept overnight in large glass troughs. It was observed that majority of alates had not shed their wings and they congregated at one corner of the glass trough. Wings were, however, shed when the alates were transferred singly or in pair to separate glass troughs. The alates were observed to shed their wings within 5 to 7 minutes after their separation from the group. The inhibitory factor against the shedding of wings in alates when kept together in the laboratory seems to be due to the crowding of alates which simulated the conditions in the nest. That the isolation of the individuals from the group seems to be needed to stimulate dealation was also observed in *Anacanthotermes ochraceus* (Clement 1956) and in *O. assmuthi* (Sen-Sarma 1962).

Calling attitude: Female alates were observed to adopt calling attitude only after the dealation. The abdomen of the female was characteristically raised at an angle of 30°C from the horizontal plane. Females move their abdomen laterally rather violently. The abdominal movement was stopped as soon as contact with the male was established. The male thus, seems to use visual clue in locating the female. It was further observed that if the male was withdrawn after the contact or was lost, the calling attitude was again adopted by the female.

Tandem behaviour: With the approach of males, the females stop movement of abdomen

and start moving forward with the males following in tandem very closely. The following males caressed the anal tip of female by means of their antennae. Duration of tandem lasted 10-15 minutes. Only female-male tandem was observed. Neither the male-female tandem as observed by Lüscher (1951) in *Kalotermes* and *Cryptotermes* nor tandem comprising only one sex was observed. The pair ultimately settled down by preparing a small chamber in soil matrix on the side of the trough. This indicates thigmotactic response and return to photonegative behaviour.

Colony foundation: For colony foundation in the laboratory, pairs of both species in tandem were released in medium sized round glass troughs filled up with 15 to 20 cm deep moist soil. A few holes were made in the matrix. Water was added as and when needed. These troughs were kept in the cellar having a temperature of 28°C ± 1°C and 90% ± 5% relative humidity. The female with the following males entered slowly into the holes, went deep and ultimately prepared a copularium. The tunnel connecting the cell to the outside was sealed up immediately. As the alates cannot take food by themselves, the pair apparently live on the food reserves in their body, till the hatched workers grew up to feed them. Out of 100 pairs 50 for *O. microdentatus* and 50 for *O. obesus* released in the glass troughs, only twenty two pairs survived, ten from *O. microdentatus* and twelve from *O. obesus* and laid the eggs. The preoviposition period was about 11-13 days. The female laid 14-16 eggs in the first batch and 24-28 eggs in the second batch on the following days. Females were observed to lay eggs continuously and the number of eggs laid increased progressively. Eggs adhered together by means of a jelly like fluid.

First batch of eggs hatched out after 40 days in *O. microdentatus* and after 40-43 days in *O. obesus*. Period from hatching to development of mature workers was 32 days in *O. microdentatus* and 30 days in *O. obesus*. First batch of workers were relatively smaller in size. The development of soldier caste could not be observed as the colonies died after ninety two days.

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FOOD AND FEEDING HABITS OF *LABEO BOGGUT* (SYKES) FROM KULGARHI RESERVOIR (MADHYA PRADESH)[1]

S. J. Karamchandani[2] and D. N. Mishra[3]

(*With two text-figures*)

Introduction

The cyprinid fish, *Labeo boggut* (Sykes), is one of the common minor carps of Madhya Pradesh. According to Day (1889), the fish is distributed in the "Central Provinces, Bengal, the Punjab, Bombay, Deccan, common to Jubbulpore and in Cutch; and Madras". The maximum length attained by this species has been recorded by Day (op. cit.) as more than 191 mm and Job *et al.* (1955) as 355 mm in Mahanadi. However, the largest specimen recorded in the present investigations measured only 198 mm in total length.

As this species does not grow to a large size, it cannot be regarded as an economical species. For the successful development of fisheries resources in the reservoir, some knowledge on the food and feeding habits of uneconomic species of fish is necessary, as they are likely to compete with cultivable major carps for food and space, resulting in the latter's poor growth. Natarajan *et al.* (1975) have stated that many of the carp minnows and trash fishes are harmful to the productivity of major carps because of the similarity in feeding habits. For the same reason the importance of control of these fishes has been emphasised by Bennett (1962), Jhingran (1965) and Natarajan (1971).

Barring a brief account on food composition of *Labeo boggut* by Chacko (1951), no detailed information on its food and feeding habits appears to be on record. The studies on this important aspect of biology of this uneconomic species were, therefore, undertaken in Kulgarhi reservoir where it is encountered in fairly large number, being an indigenous species of the surrounding waters.

Material and methods

The material for the present study was obtained from cast net fishing. Altogether, 546 specimens of *Labeo boggut* measuring 63-198 mm in total length were examined from July 1970 to June 1971 for studying its food and feeding habits.

The guts were removed from fresh specimens and preserved in 5% formalin for subsequent study. The contents of the preserved guts were pooled monthwise in order to save time and labour and to minimise error in the estimation of food components, following a method given by Karamchandani & Desai (1962). While drawing samples for microscopical examination, the pooled gut-contents were thoroughly mixed and the gut-contents were analysed by

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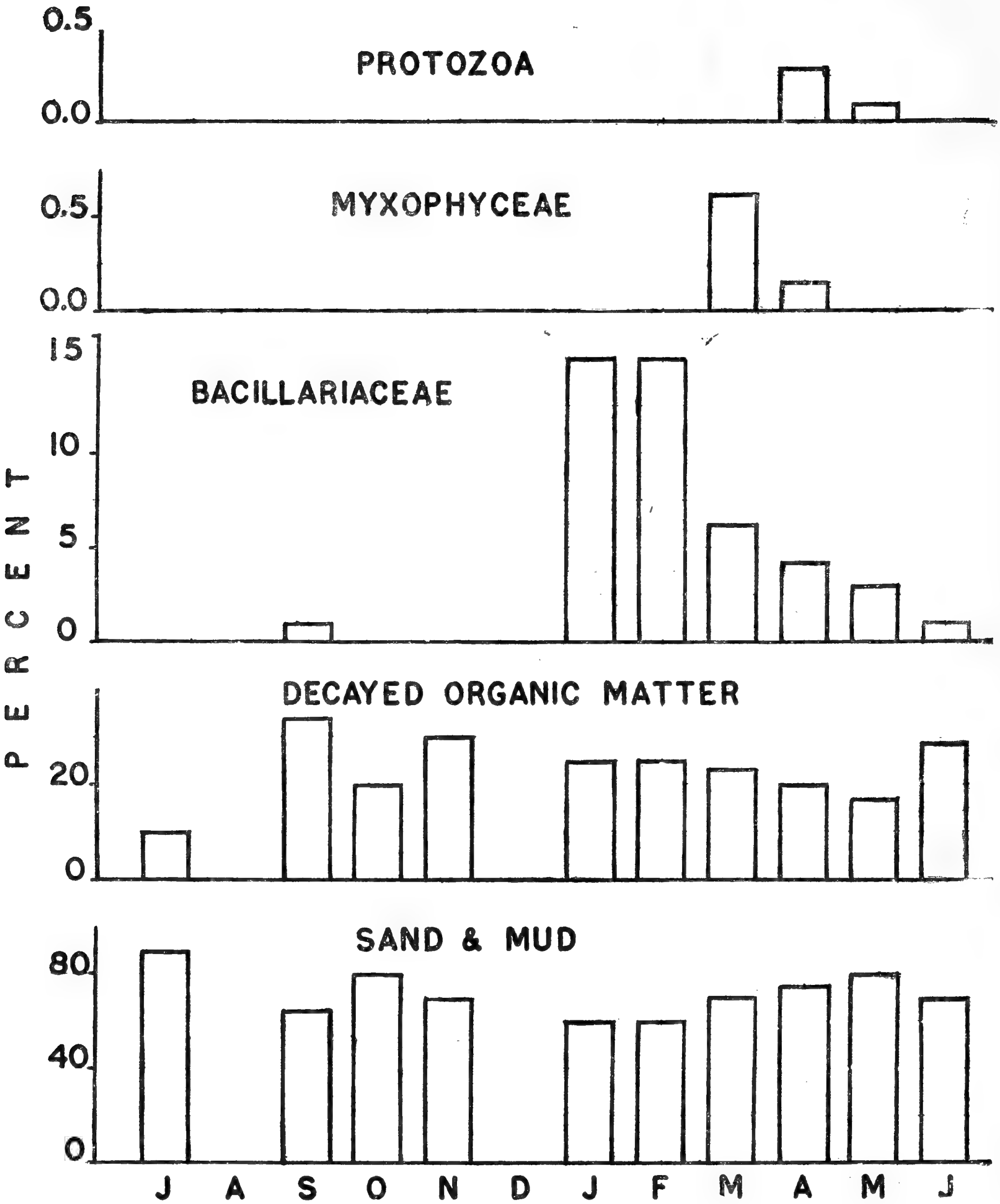

Fig. 1. Fluctuations of broad groups of the gut contents of *Labeo boggut* (Sykes) in various months. (The samples were not available in the months of August and December).

modified points method adopted by Bhatnagar & Karamchandani (1970).

The feeding intensity was measured by recording the 'condition of feed' of the guts which were classified as full, $\frac{3}{4}$ full, $\frac{1}{2}$ full, $\frac{1}{4}$ full, trace and empty, depending on the degree of distension of the guts and the amount of the gut-contents. The 'condition of feed' as recorded in the present study is expected to depict a correct picture of feeding intensity, as the fish samples were obtained from the cast net catches and the guts were removed from fresh specimens and immediately preserved in formalin. The feeding intensity as expressed by 'condition of feed' was correlated with condition factor 'K' ($K = W x 10^5/L^3$, where W= weight of fish (gm), L=Total length (mm) of fish) and relative condition 'Kn' (Kn = Wo/Wc, where Wo=observed weight (gm), Wc= calculated weight (gm) by Length-Weight relationship formula), with a view to determine whether wide variations, if any, in 'K' and 'Kn' values were due to feeding or some other factor.

Observations

(i) *Composition of gut-contents*:— The overall picture of the broad groups of gut-contents, by volume, of *Labeo boggut* for the period July 1970 to June 1971 is given in Table 1 and their fluctuations in various months are shown in Text-fig. 1. The month-wise fluctuations of various components are presented in Table 2 and the salient features thereof are enumerated below:

(a) *Mud mixed with sand*: This item which was encountered in the guts throughout the year constituted the main bulk of the gut-contents and its volume ranged from 65.0% in September to 90.0% in July, the average being 72.0%.

TABLE 1

BROAD GROUPS OF THE GUT-CONTENTS OF *Labeo boggut* (SYKES)

Broad groups of gut-contents	Percentage composition
Mud mixed with sand	72.00
Decayed organic matter	23.30
Planktonic food	
Bacillariaceae	4.59
Myxophyceae	0.08
Protozoa	0.03
	4.70

(b) *Decayed organic matter*: This mainly comprised unidentifiable mucilaginous mass of decayed plant matter of greenish dirty colour. It occurred regularly in the guts throughout the year. Next only to mud and sand, this matter made up considerable bulk in the gut-contents, constituting on an average 23.3% by volume. The large quantities of this matter occurred in September (34.0%), November (30.0%) and June (29.0%). It was moderately encountered from January to May (17.0% to 25.0%) and poorly in July (10.0%).

(c) *Planktonic food*: This item comprised planktonic organisms, belonging to Bacillariaceae, Myxophyceae and protozoa and made up 4.7% in the total gut-contents. The content of planktonic forms in the guts was maximum during January and February (15.0% in each month).

Bacillariaceae (Diatoms): Among the identifiable planktonic food, the diatoms were the most abundant (4.59%) in the total gut-contents. This group was represented by genera *Diploneis* (2.31%), *Melosira* (1.44%), *Gyrosigma* (0.71%), *Navicula* (0.11%) and *Amphora* (0.02%). Of these, *Diploneis*, the most important genus, occurred abundantly in January (13.47%) and February (6.85%), scarcely in March (1.45%) and May (1.29%) and

TABLE 2

MONTHWISE FLUCTUATIONS OF VARIOUS COMPONENTS OF GUT-CONTENTS (% BY VOLUME) OF *Labeo boggut* (SYKES)

Months	July, 1970	Aug.*	Sept.	Oct.	Nov.	Dec.*	Jan. 1971	Feb.	March	April	May	June
Size - range (mm)	105–147	—	117–156	63–155	131–135	—	69–165	80–185	87–198	92–190	100–145	100–165
Guts containing food (%)	100.00	—	100.00	100.00	100.00	—	100.00	100.00	100.00	100.00	97.18	87.50
Gut-contents:-												
Mud mixed with sand	90.00	—	65.00	80.00	70.00	—	60.00	60.00	70.00	75.00	80.00	70.00
Decayed organic matter	10.00	—	34.00	20.00	30.00	—	25.00	25.00	23.00	20.00	17.00	29.00
Bacillariaceae:												
Diploneis sp.	0.00	—	0.00	0.00	0.00	—	13.47	6.85	1.45	0.00	1.29	0.00
Melosira sp.	0.00	—	0.92	0.00	0.00	—	1.12	7.74	2.00	2.00	0.52	0.11
Gyrosigma sp.	0.00	—	0.00	0.00	0.00	—	0.00	0.00	2.92	2.29	1.03	0.81
Navicula sp.	0.00	—	0.08	0.00	0.00	—	0.18	0.41	0.00	0.28	0.08	0.08
Amphora sp.	0.00	—	0.00	0.00	0.00	—	0.23	0.00	0.00	0.00	0.00	0.00
	0.00	—	1.00	0.00	0.00	—	15.00	15.00	6.37	4.57	2.92	1.00
Myxophyceae:												
Merismopedia sp.	0.00	—	0.00	0.00	0.00	—	0.00	0.00	0.63	0.15	0.00	0.00
Protozoa:												
Difflugia sp.	0.00	—	0.00	0.00	0.00	—	0.00	0.00	0.00	0.28	0.08	0.00

* Samples not available.

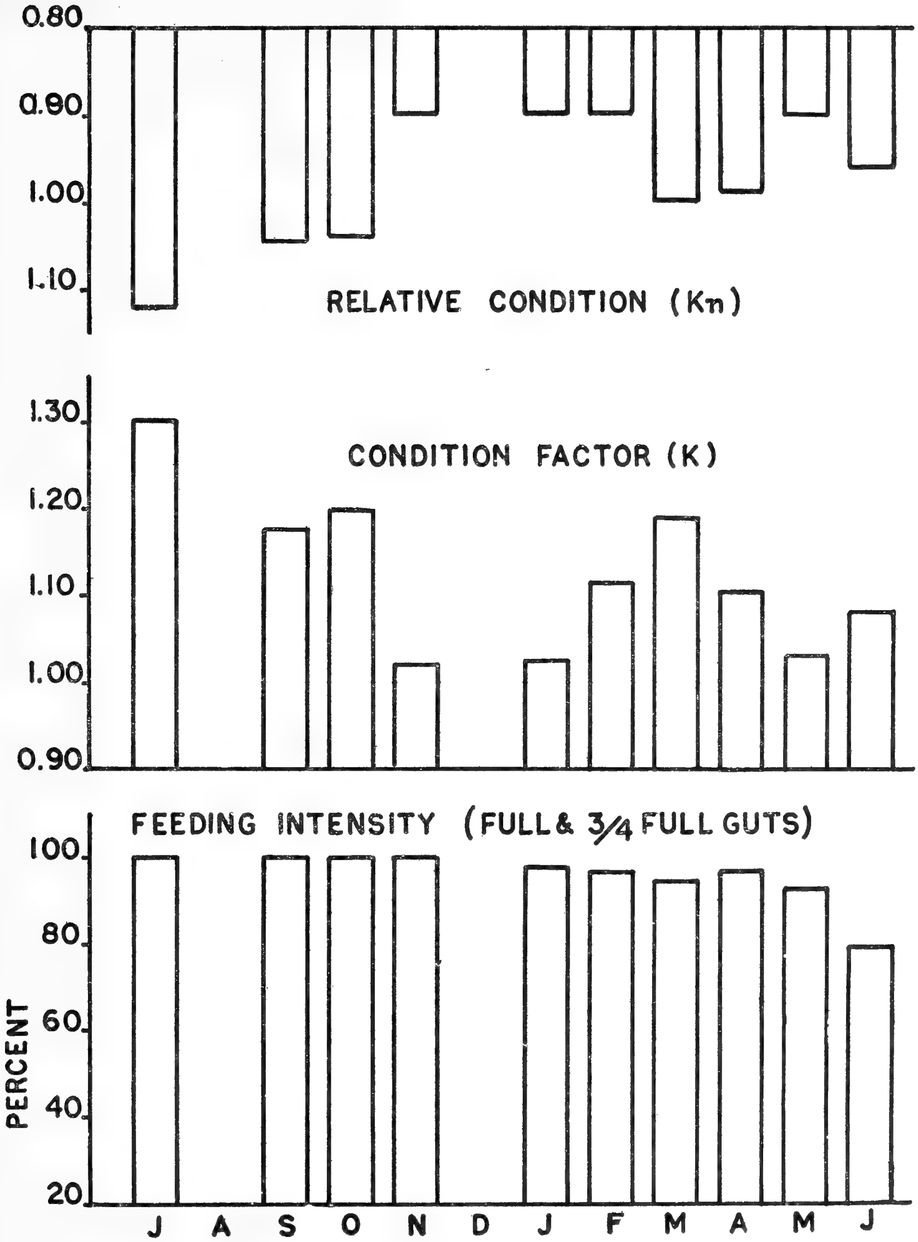

Fig. 2. Fluctuations in the feeding intensity, condition factor (K) and relative condition (Kn) of *Labeo boggut* (Sykes) in various months. (The samples were not available in the months of August and December).

was totally absent in rest of the months of observations. *Melosira,* the next important genus, occurred in fairly large quantity in February (7.74%), scarcely in January, March to June and September (0.11 to 2.0%) and was totally absent in rest of the months of observations.

Myxophyceae (Blue-green algae): The blue-green algae, represented entirely by genus, *Merismopedia,* made up 0.08% in the bulk of the gut-contents. It was found to occur in the months of March (0.63%) and April (0.15%) only.

Protozoa: This group, comprising genus *Difflugia* only, made up 0.03% in the bulk of gut-contents and occurred in the months of April (0.28%) and May (0.08%) only.

(ii) *Feeding intensity and 'condition' of fish*: The percentage of $\frac{3}{4}$ full and full guts, indicating feeding intensity and the values of condition factor (K) and relative condition (Kn) are depicted monthwise in Text-fig. 2.

As may be seen from Text-fig. 2, the feeding intensity was pronounced almost throughout the year, the percentage of $\frac{3}{4}$ full and full guts mostly ranging from 92.65 to 100. Whereas, the values of 'K' and 'Kn' varied regularly, having two minima in November and May and two maxima in July and March. A positive correlation was found between the feeding activities and condition factor (K) in *Tor tor* (Ham.) by Desai (1970) and in *Labeo fimbriatus* (Bloch) by Bhatnagar & Karamchandani (1970). However, in the present case, there is no direct correlation between these variables.

(iii) *Competition for food with major carps*: With a view to evaluate the status of *L. boggut* in the economy of fish culture in Kulgarhi reservoir, its food has been compared with that of Mrigal and Rohu in Table 3, as the former feeds entirely and the latter partly at bottom, like *L. boggut*.

TABLE 3

COMPOSITION OF GUT-CONTENTS OF *Labeo boggut, Cirrhina mrigala* AND *Labeo rohita* FROM KULGHAHI RESERVOIR

Items of Gut-contents	Percentage composition of gut-contents		
	L. boggut	*C. mrigala*	*L. rohita*
Mud mixed with sand	72.00	65.66	57.24
Decayed organic matter	23.30	24.69	29.16
Diatoms	4.59	8.14	5.68
Green algae	0.00	0.94	3.57
Blue-green algae	0.08	0.27	1.22
Dinoflagellates	0.00	0.17	2.44
Rotifers	0.00	0.13	0.62
Protozoans	0.03	0.00	0.07
Total	100.00	100.00	100.00

Of the planktonic food, *Melosira, Navicula* and *Gyrosigma* among diatoms, *Merismopedia* among blue-green algae and *Difflugia* among protozoans were commonly encountered in the guts of *L. boggut* and the two major carps.

As the bulk of the gut-contents of *L. boggut, C. mrigala* and *L. rohita* (99.89%, 98.49% and 92.08% respectively) comprises mud mixed with sand, decayed organic matter and diatoms (Table 3), the food and feeding habits of three species are almost comparable, indicating their bottom feeding habits in the reservoir.

REMARKS

Uneconomic species of fish which are invariably abundant in the reservoirs are considered responsible for low fish production in such waters as they are reported to compete, for food and space, with cultivated species of major carps. *Labeo boggut* contributes a major share (27.6% by number) to the catches of

uneconomic species of Kulgarhi reservoir, which called for detailed investigations on one of the important aspects of its biology—the food and feeding habits.

The observations made in the present study indicated that though the feeding intensity, as determined by 'condition of feed' in the guts, was pronounced almost throughout the year (92.65% to 100.00% $\frac{3}{4}$ full and full guts), the 'condition' of fish ('K' and 'Kn') showed wide variations giving two maxima and two minima (Text-fig. 2) during the course of the year. Generally, the 'condition' of a fish is greatly influenced by its feeding activities (Desai, op. cit. and Bhatnagar & Karamchandani, op. cit.). But, in the present case, the two variables do not exhibit any direct correlation between them. It is, however, interesting to note that when the fluctuations of main components of the gut-contents (Text-fig. 1) are compared with those of 'K' and 'Kn' values, the mud mixed with sand which forms the bulk of the gut-contents exhibits almost the same trend as those of 'K' and 'Kn' values.[4] This gives strong indication that the fish in all probability draws nutrition from mud and sand (72.0%) mixed with fine organic matter and also from decayed organic matter (23.3%), particularly when the plankton content in the guts is strikingly very low (4.7%). These observations amply lend support to those by David *et al.* (1969), who have stated to the effect that the deposited particulate organic matter (in ooze) and epiphyton form considerable part of food for bottom feeders as well as young stages and smaller species of fishes.

Job *et al.* (1955) have stated that the cultivation of slow growing fish, *Labeo boggut*, along with fast growing, economically important species—the major carps should be avoided evidently because the former does not attain a very large size in its life time and competes for food and space with the latter species. The composition of the gut-contents of *L. boggut*, in the present case, has confirmed that it is a bottom feeder as its guts were found gorged with mud mixed with sand and debris (Text-fig. 1 and Table 1) and its comparison with that of *Cirrhina mrigala* and *Labeo rohita* has indicated that its feeding habits are highly identical to those of the two major carps (Table 3).

Though in the present study the food of *Labeo boggut* measuring below 63 mm was not studied, it seems very likely that the young fry of this bottom feeding fish, like adult, does not feed on zooplankton, as the carp fry in general have been found to subsist mostly on phytoplankton by some workers. Hora (1943) observed that the micro-phytoplankton serves as food of the fry of carps in their earlier stages of growth. According to Mookerjee (1944, 1945), 5 to 10 mm long fry of Indian major carps namely *Catla catla, Labeo rohita* and *Labeo calbasu* feed exclusively on unicellular algae and from 10 to 20 mm stages, they feed on protozoa of various kinds. Chacko & Kuriyan (1948) stated that the food of fry of *Labeo fimbriatus* is similar to that of the adult but lacks crustacean and insect remains. Bhatnagar & Karamchandani (op. cit.) found the food of fry of *L. fimbriatus* comprising of mostly phytoplankton, the zooplankton (copepods) being only 0.2%.

Since in Kulgarhi reservoir *L. boggut* and the two major carps have been found to subsist mostly on bottom mud mixed with debris and draw nutrition from it the plentiful availability of this item at the reservoir bottom is not likely to cause active competition for food

[4] However, as may be expected, during the maturing period of gonads from March to June, 'K' and 'Kn' values show downward trend opposite to that of mud mixed with sand.

among them. It is, therefore, apparent that the presence of *L. boggut*, the indigenous species of the reservoir, would not adversely affect the culture fishery of the reservoir, but, on the contrary it would add substantially to the reservoir fishery, it being abundant there.

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SOME ASPECTS OF THE ECOLOGY AND BEHAVIOUR OF THE INDIAN FOX—*VULPES BENGALENSIS* (SHAW)[1]

A. J. T. JOHNSINGH[2]

This brief report on the Indian Fox (*Vulpes bengalensis*) is based on intermittent obervations in the grassy plains and rocky areas lying to the North West of Nanguneri (8°30′N and 77°70′E) in Tirunelveli District, Tamil Nadu. The foxes inhabiting the open lands littered in complex cavernous dens with many entrances but in the rocky area dens dug under the rocks and into the rock crevices were preferred. The pups were observed to frequently play around the den entrances in the months of April and May, when they were around 2-3 months old. Though the Indian Fox is a solitary hunter it seems to be more sociable in nature. Hunting was mostly done early in the morning, late evening and night. Insects and terrestrial rodents formed the staple food of this canid. The Indian Fox was observed to tolerate the presence of the common mongoose (*Herpestes edwardsi*) in the vicinity of its den. Mortality was mostly due to man and dogs. The future of the Indian Fox in the rocky area appears to be safe.

INTRODUCTION

The Indian Fox, *Vulpes bengalensis* (Shaw), is the common fox of the Indian plains found in the whole of India from the foothills of the Himalayas to Cape Comorin (Prater 1971). Its successful survival is presumably due to its small size, reproductive capacity, denning and feeding habits and its general adaptability. The Indian Fox, though common in the study area, is absent from the neighbouring Western Ghats, which rise 16 km away in the west. The probable reason for this could be that foxes as they chase and hunt small prey such as insects and rats are more adapted to hunting in the plains than the vegetation covered hills. Like other foxes, the Indian Fox is also a solitary hunter. Although common in India, within my knowledge, not much work has been done on this animal. The study presented here is a preliminary attempt made on some aspects of the ecology and behaviour of this canid.

STUDY AREA AND METHODS

I have been familiar with the Indian Fox for over the last fifteen years in the field but only from the summer of 1974 did I start observing and studying them intensively. The observations could only be sporadic as the study area was visited only during the holidays.

The study area was the grassy plains with rocky hillocks, lying to the North-West of Nanguneri (8° 30′ N and 77° 70′ E) in Tirunelveli District, Tamil Nadu. This is a good habitat for the Indian Fox and sighting of foxes is assured to any one who walks in this area either in the early morning or late in the evening. Temperature data for Nanguneri which lies 17 km East to the Kalakadu hills of the Western Ghats are not available. But the temperature of the nearest town Palayamkottai, 29 km to the North, varies between 24°C and 40°C. The area gets most of its rain from the North East monsoon and most of the rainfall

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is between the months of October and December. The precipitation varies between 50 and 70 cm per year. (Sivasailam, Pers. Communication).

I concentrated my study on two areas. One was a square kilometre open land with four waterless sandy streambeds meandering through it. On the western and Northern sides of this plot are fields; on the eastern side the Kasi-Kannyakumari Trunk Road and on the southern side an industrial complex. From dawn to dusk, the area was intensively disturbed by cattle, sheep and people. An average of 2-4 adult foxes were seen in this area. In total, the area had 8 dens, both old and new. The other area selected was rocky and was surrounded by a vast plain, dotted with palmyra palms (*Borassus flabellifer*) and rocky outcrops. This area has been a favourite home of foxes for years.

Observations were made mainly in the evening and some times in the morning. A total of approximately 60 hours was spent in the field in search and observation of foxes. In the open land the foxes were observed from the cover of bushes or by stalking upwind. The den among the rocks was easy to observe as I had a suitable hideout in the neighbouring rock outcrop. But observations were possible only when the wind was in favour. Occasionally droppings from the den sites and nearby areas were collected to study the food habits. Two foxes killed by dogs were examined for parasites and stomach content. My observations on the pups were mainly carried out in the summer of 1976. When I was successful in locating 5 active dens inclusive of the two from the study area. Of the rest, two were among the rocks and one amidst hardened sand outcroppings on the banks of a sandy stream bed.

The flora of this semi-arid area is spiny and many have milky latex characteristic of desert plants. Common trees were the palmyra palm (*Borassus flabellifer*) and *Acacia planifrons.* The exotic thorny shrub *Prosopis juliflora* had also established itself successfully. Common herbs were the *Calotropis gigantea, Cassia* spp. *Alysicarpus parviflorus, Triumfetta rhomboidea* and *Barleria* spp. *Aristida setacea, Aristida hystrix, Perotis indica, Heteropogon contortus, Tragus biflorus, Chloris barbata* and *Cyanodon dactylon* were the common grasses.

Results and discussion

Food and feeding habits

My observations on the feeding habits of the Indian Fox were limited by the fact that they were crepuscular and nocturnal. The most widely applicable statement that can be made safely is that foxes are opportunistic feeders and so take any acceptable food in proportion to its availability (Ables 1975). Melons, ber fruit, and the shoots and pods of *Cicer arietum* are eaten in season (Prater 1971). Local shepherds have seen the foxes eating the freshly voided pellets of sheep. They were seen hunting insects such as the winged termites and grasshoppers. They used their jaws to snap them in the air and their forelegs to pin them on the ground. Stomach analysis of one fox showed that they eat beetle grubs and of another showed only the hairs of the soft furred Field Rat.

From scat analysis it was found out that the food of the Indian fox was mainly composed of beetles, grasshoppers, crabs, ground lizards, soft furred Field Rat and Field Mouse. Occasionally, they ate scorpions (*Buthus* spp.), ants (*Componotus compressus*), termites (*Acanthoptermes* spp.) and spiders. A search around the dens yielded the scales and ventral plates of a Ratsnake, the skin of the Hedgehog, fea-

Common vertebrate fauna of the study area

Common name	Scientific name	Remarks
Garden lizard	*Colotes versicolar*	Probable food
Fanthroated lizard	*Sitana ponticeriana*	Probable food
Rock lizard	*Psammophilus* sp.	Probable food
Grey Partridge	*Francolinus Pondicerianus*	Occasionally roosts on the ground Probable food
Redwinged Bushlark	*Mirafra erythroptera*	Probable food
Blackbellied Finchlark	*Eremopterix grisea*	Roosts on the ground. Probable food
Yellow-wattled Lapwing	*Vanellus malabaricus*	Roosts on the ground
Indian Myna	*Acridotheres tristis*	
Indian Pipit	*Anthus novaeseelandiae*	Roosts on the ground. Probable food
Little Ringed plover	*Charadrius dubius*	Local Migrant
Cattle Egret	*Bubulcus ibis*	?
Indian Courser	*Cursorius coromandelicus*	?
Hedgehog	*Paraechinus nudiventris*	Probable food
Softfurred Field Rat	*Millardia meltada*	Probable food
Three stripped Palm squirrel	*Funambulus palmarum*	Probable food
Field mouse	*Mus booduga*	Probable food
Blacknaped hare	*Lepus nigricollis*	Young ones Probable food

thers of the Indian myna, Blackbellied Finch Lark and Grey Partridge. As the foxes groom and bite themselves to get rid of the ectoparasites there is a possibility, as evidenced by faecal analysis, of their swallowing their own hairs. Besides the hairs, the hard bones, teeth, chitinised mandibles, insect legs, elytra of beetles, wings of grass hoppers and fragments of grasses formed part of the droppings. In general it can be said that the food of the Indian fox in the study area was mainly composed of insects, ground nesting birds and smaller mammals. The small size of the prey is the major possible reason for the fox to be a solitary hunter. In fact, the expenditure of energy of two or more foxes cooperating to kill one mouse would be maladaptive (Fox 1975).

Droppings of the cubs, that had not started following the adults for hunting, mostly had digested meat, and hair of either the soft furred Field Rat or the Field Mouse. This suggests the possibility that their principal diet was of milk and small rodents brought to the lair by the adults.

Dens and denning behaviour

The dens of the Indian Fox could be grouped into three types: 1) Simple short dens with two openings; 2) Complex cavernous dens with many entrances; 3) Dens under rocks and rock crevices.

One den belonging to the first type was seen in the study area in the open land. Its interior was 45 cm long, 40 cm broad and 30 cm high. This was seen at the edge of a man-made pit. Obviously such dens are used for brief periods of rest. Such short and simple dens could be called ‘cooling holes’ or protective ‘bolt holes’. But this type of den was rare.

The second type was the commonest. In the

one square kilometre study area there were eight such dens. During the non-breeding season all the dens had a deserted appearance and during the breeding season, as the need rose, the dens were freshly dug out. The number of entrances varied between 6 and 23. In the number of den openings the early observations done on the other species of foxes can be recalled here. The Alaskan fox had dens with upto 19 entrances (Murie 1944), the Red Fox in North America had 12 or more openings (Ables 1975) and the Arctic Fox in North Alaska has 26 entrances (Chesemore 1969). Two dens were on sand mounds. Owing to the grass cover, the dens dug on the plains were mainly hidden from view at a distance. But on going nearer the den, one may be attracted by the sand thrown at the entrances, especially with the arrival of the breeding season when foxes reexcavate their dens. The structure of such a complex den is described by Prater (1971) and it needs no further elaboration here. As there are many holes leading into such a complex den, the interior is presumably well ventilated and is certainly not in total darkness. Most of the abandoned den openings were clogged by wind-blown grasses and debris. Vegetation in the area of a complex cavernous den appeared slightly better than that of the surrounding area. This phenomenon more prominently seen in the den site of the Arctic Fox (*Alopex lagopus*) has been noted by Chesemore (1969). According to him the change is due to the addition of organic materials to the soil plus the physical disturbances, aeration and mixing of the soil that occur when a fox digs and uses a den site.

The Indian Fox seems to be attached to favourite den sites. According to Murie (1944) and Ables (1975) there is strong evidence that adult Red foxes in North America remain in the same home area for life. The dens reported by Ables (1975) were used more or less continuously for periods of at least 35 years. He says that such dens are traditional and are at a premium because of the scarcity of suitable sites. The den among the rocks in the study area was seen tenanted for well over 15 years, and in the study area in the plains, inspite of the growing disturbance, the foxes preferred to stick to their den sites. One den site, which was active in the summer of 1976, had six openings and was about 70 metres from a cart track that was often used by pedestrians, cyclists and occasionally by heavy traffic. The foxes, when disturbed while resting away from the dens, very often took refuge in the den instead of running away. Some of the dens, dug out in hard-baked earth, gave the foxes needed protection from the piedogs which are their main enemy besides man in the study area.

The Indian fox also has the habit of sleeping under bushes during the hot hours of the day. Such places are easily identified by their concavity, absence of grass and by the presence of well churned fine sand. Such places could be called 'cool earth pits'. The Indian fox does not seem to be particular about den cleanliness as their den surroundings were littered with their droppings, especially when the dens were occupied.

Reproduction, family unit and home range

In the Indian Fox there appears to be a persisting bond between the members of a pair. This is based on three sightings of the pair of foxes. Twice they were seen in the month of April (post reproductive period) and once in September (pre reproductive period), when the pair was observed in April once the vixen was lying fully stretched on the ground and the male lying nearby nibbled at the pinna of the female. But when the time for hunting came both parted. Further study is needed to confirm the valid evidences for or against this

speculation. According to Acharjyo & Misra (1976) mating in the Indian Fox is just as in domestic dogs. The birth of the young in the Indian Fox, as in all wild canids occurs with maximum availability of prey that is, when the latter are rearing their young and in the study area this happens around January. During this season the lush vegetation after the North East Monsoon affords not only cover but also abundant insect food. The gestation period lasts for 53 days (Prater 1971), 50-51 days (Acharjyo & Misra 1976) and usually 2 - 4 young ones are born. The vixen observed by Acharjyo & Misra (1976) gave birth to 4 pups towards March end. Both the active dens in the study area had four pups each.

The age of the pups in the beginning of the observation period was nearly 2 months and observations were carried out till the pups were almost 4 months old. The pups were very playful till they were 3 months old. The male was observed with the pups four times. During this only once did the male rebuff a pup, which attempted to play with it, with a growl and an inhibited bite. At all other times the male played with the pups. The inhibited bite of the male on the pup suggests the possibility that the male was confirming its dominance over it.

During the observation on the play behaviour of the pups, I watched them making vertical leaps, back-arching, hip and shoulder body slams, foreleg stabs, and submissive display by rolling on the back and exposing of the throat. Play soliciting was common. Occasionally, the pups left their play—partners abruptly and indulged in digging up the soil. The pups in the open land used to remain immobile while watching the pedestrians, cyclists, cattle, sheep and the occasional stray dogs which sometimes went as close as 30 metres. But on the least suspicion the pups always ran inside. While coming out of the den in the open land the pup that came out first always looked around, keeping the head level with the ground. Once it had come out, other pups mostly followed it without looking around. Twice the pups were watched while defecating. They moved 4 - 5 metres from the den and defecated. The African wild dog pups observed by Kuhme (1965) defecated one or two metres from the entrance.

The pups in the openland den seldom played in the absence of adults. But the pups of the rocky den were full of play even in the absence of the adults. This may be due to the confidence engendered by the safe position of the den. The Red Fox in mid-wales in Britain will move pups with little provocation (Lloyd 1975) and as reported by the local people this is said to occur in the Indian Fox also. Other canids that shift the dens are the African wild dog (Kuhme 1965; Schaller 1972; H. & J. Van Lawick - Goodall 1970); the wolf (Murie 1944; Mech 1970), the Indian Wild Dog (pers. observation) and the Indian Jackal (Samuel, pers. communication).

On the evening of 24th April 1976 four pups were being watched beside the den in the open land. At 1830 hours a female came out of the den and all the four pups ran to it and were suckled for half a minute. Then came out another female. The pups leaving the first female ran to it and were suckled for 2 minutes. From the den a male also came out. This type of suckling behaviour has been observed in the bat-eared Foxes (*Otocyon megalotis*) (H. & J. Van Lawick-Goodall 1970), in African Lion (Kruuk 1972, Schaller 1972), in African wild dogs (Kruuk 1972, Schaller 1972, Kuhme 1965).

There could be two possible reasons for the two females to have suckled the 4 pups. One reason could be that both the females might

have littered in that den and the entire surviving bunch of pups was being fed by both the vixens. The other reason could be that one mother could have lost all her young in the early postnatal period and it could have 'helped' the other in raising the litter. Another time, in the rocky area five almost full grown foxes, probably of the same family, were sighted resting under a rock in the noon day sun. Aggregations like this suggest the possible fact that the Indian Fox is sociable in nature.

In the open land study area, in the summer of 1974 there were two breeding pairs. In the nearby Farm forest which lies barely 100 metres from the study area on the eastern side there was another active den. In such areas there is a liability for the home ranges to overlap and a possibility for conflicts too. But as interpreted by Leyhausen (1965) these conflicts may seldom arise.

Communication in the Indian Fox:

The common vocal sound produced by the Indian Fox is the chattering cry which may be used as an alarm call also. Besides, they growl, whimper, whine, and they make a sound which could be called a growl bark. Once a male was seen urinating like a domestic dog but there was no smelling ceremony preceding it. The Gray Fox (*Urocyon cinereoargenteus*) defecates along road sides in or beside trails often in small concentrations. These scent posts may aid them in marking territories (Trapp 1973). Other animals that have been observed to defecate at specific latrine sites are the spotted Hyena (Kruuk 1972) the members of a banded mongoose group (Schaller 1972) and the Indian Wild dog (pers. observation). The Indian fox does not defecate in particular places or in small groups. Whether they use their droppings for communication is to be examined.

Behaviour of the Indian Fox:

The Indian Fox moves around at dawn and in the evening. In the hot hours of the day they retire to cover. If the temperature is mild as in rainy days, they hunt even at midday. Twice during hot weather a pair was seen resting in their hiding place close by a water hole. Often they were seen spending considerable time lying on the rocks or other vantage points, basking in the rising or setting sun. The Indian Fox usually waited for darkness to descend before starting its evening hunt. But the cessation of a downpour and a cloudy day brought it out of dens even in midday.

Once they get used to the farmers and shepherds they do not get easily frightened. Local shepherds have seen them playing with their sheep and the yelling of shepherds from a distance of 200 - 300 metres did not make them scurry into their dens. When cornered in a rocky terrain, a fox crouched flat on the ground trying to escape attention. Foxes do have a fairly good sense of smell and once a male smelt me hiding 10 metres away.

Foxes do not run long distances to capture prey but to escape from dogs they run fast and long. When chased by dogs their speed is remarkable. They seem to adjust their speed in accordance with the chasing animal. When it was a man they ran slowly and when it was a dog they ran fast. While running fast the tail was kept horizontal and the foxes were able to deceive many times the chasing dogs by dexterously twisting the black bushy tail. Possibly, this was achieved by misdirecting the bites of the chasing dogs and in quick turnings, naturally, the bushy tail gave one direction while the body went in the other direction.

Interspecific relations:

The rocky den area was inhabited by the Rock-lizard (*Psammophilus*), Three Striped Palm squirrel (*Funambulus palmarum*) and

Common mongoose (*Herpestes edwardsi*). The den of the mongoose was 10 metres away from the fox den that was under observation. The Palm Squirrels which nest in the nearby palmyra palms and Euphorbia (*Euphorbia antiquorum*) often came very close (3 - 4 metres) to the playing and resting foxes but they were very wary. The squirrels are potential prey and were afraid of the foxes and this was indicated by the fact that whenever the foxes went down from the rocky den the squirrels feeding closeby on the ground ran for safety sounding their alarm call.

The Common mongoose which weighs around 2 kg and the foxes were afraid of each other and they lived in 'armed neutrality'. The mongoose which can prey upon a half grown black naped hare (personal observation) occupied the same ecological niche as the fox and seemed to live without any major conflict. Once near the rocky den a full grown fox was sitting and grooming. A half-grown mongoose, feeding nearby, suddenly rushed at it forcing it off. Latter the fox followed the mongoose and twice charged at it. The first time the mongoose ran off screeching but the second time when the fox attacked, the mongoose crouched defensively and bristling its tail hairs fended off the attack.

The Indian Fox was indifferent to Cattle Egrets (*Bubulcus ibis*) and the latter also were not unduly alarmed when the foxes moved about in their proximity. Once a cattle Egret, that had been shot, was left by the side of the rocky den but it did not interest the vixen and her two cubs playing nearby. But a Common mongoose, as soon as it came out of its den, dragged the cattle egret into its den but by this time the foxes had retreated into their den.

The Yellow-wattled Lapwing (*Vanellus malabaricus*) and the Indian Myna (*Acridotheres tristis*) were overtly alarmed by the Indian Fox and whenever the foxes moved about in their vicinity they flew off with their characteristic alarm call. The Indian Robin (*Saxicoloides fulicata*) which nested in the nearby *Euphorbia antiquorum* gave its warning notes whenever the foxes passed close to its abode. An Indian pipit (*Anthus novaseelandiae*) in the act of feeding, once went nearer (3 metres) to a male fox resting in the shade of a rock from the morning sun. But the fox simply eyed it without making an attempt to pounce on the bird.

Dangers and early mortality

In the study area the major danger to the fox comes from man especially from the nomadic *Narikuravas* and dogs. Occasionally the *Narikuravas* visit the area and with their ability to mimic the sound of foxes they easily net and kill the foxes for flesh, teeth, claws and skin. They also use hand made animal-fat-covered country bombs to kill the foxes. Further danger comes from the local 'hunters' who do not hesitate to shoot at or attempt to kill this small canid with their dogs. In summer, 1976, the active den of the Farm forest had 3 young pups but the mother was killed by dogs. My efforts to trace the fate of the pups were not successful. In the same summer, towards the end of my observation period, I found most of the entrances to the active den in the open land, where I had watched the four pups, two females and one male, jammed with stones. There was no trace of the foxes. Early mortality owing to natural causes may also be a danger to their lives. During the first week of April in the summer of 1975, the den among the rocks had 3 pups but around the end of May I continued to see only one pup. Two Indian Foxes killed by dogs were checked for macro endoparasites but none were found. This does not mean that the

foxes were devoid of endoparasites. The Indian Fox has the habit of biting often at places like the base of the tail and this may be due to infection of ectoparasites.

Any account of the Indian Fox ecology will be incomplete without considering the economic values, both positive and negative. On the negative side, predation on Partridges and young Hare which are valuable small game can be considered. Foxes are potential carriers of rabies. There is record of the Arctic Fox in Alaska having rabies during high population period (Rausch 1958). But there was no local report of the Indian Fox suffering from or transmitting rabies. Further there was no local record of the Indian Fox raiding either poultry or attacking sheep.

On the positive side, foxes prey on rodents, land crabs and insects which cause considerable damage to our crops. At present a balance sheet would probably show the Indian Fox with more positive values. While judging from my findings it would appear that the vermin status of the Indian Fox as declared by the wild life Act 1972 is unjustifiable. Prater (1971) is also of the opinion that the Indian Fox by its constant destruction of rats and land crabs does real service to the farmer. Intensive studies on this aspect of the Fox ecology in other parts of the country are urgently needed to re-avaluate its status.

Finally while mentioning about the future of the Indian Fox in the study area it can be said that before the ill-informed local people and the rapidly expanding human exploitation of the habitable areas one cannot be optimistic about the survival of the Indian fox tenanting the open land. But the rugged terrain of the rocky area, being suitable neither for cultivation nor for human settlement, hopefully may continue to give safety to and support a population of the Indian fox for many more years to come.

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BEHAVIOURAL VARIANTS OF BONNET MACAQUE (*MACACA RADIATA*) INHABITING CULTIVATED GARDENS[1]

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(*With a text figure*)

Bonnet macaques, *Macaca radiata,* inhabiting cultivated gardens were studied. The number of troops per km^2 was small but the troop size was large. Three troops with a mean of 40 individuals per troop were located in a 10 km^2 area. Main activities like feeding, grooming and breeding were regulated by seasonal fluctuations and there was a selective breeding among females and dominant males. Two distinct peaks in the grooming frequency were recorded, one when the copulation frequency was high and the other when the babies were 2-4 months old. There was an association and interaction between monkeys and other species.

Inspite of a large number being killed, they were on the increase mainly because of their ability to keep out of harm's way and to readjust themselves to changing habitat.

A linear social ranking order was noticed during aggressive and submissive episodes.

INTRODUCTION

The Bonnet macaque, *Macaca radiata* occurs in the southern half of Indian Peninsula from the evergreen forests of the Western Ghats to the dry areas of the Deccan Plateau. It coexists with the lion-tailed macaque, *Macaca silenus* in the evergreen high forests of the South Indian high ranges; with the Hanuman langur, *Presbytis entellus* in the dry, deciduous forests of the Western Ghats (Sugiyama 1964, 1968 & 1971); and with the Nilgiri langur, *Presbytis johnii* in the Nilgiri Hills (Poirier 1970).

Nolte (1955) began the study of the socio-ecology of this primate and investigations have later been undertaken by Simonds (1965), Kaufman & Rosenblum (1966), Rahaman & Parthasarathy (1967, 1968, 1969 a, b, and 1971 a, b) and Sugiyama (1971).

All these investigations were on monkeys inhabiting forests, roadsides or parks with neither much human interference nor seasonal fluctuations.

The present study is on bonnet monkeys that were forced to readjust themselves to modified ecological factors due to conversion of their original habitats into gardens. As they were originally forest dwellers, a comparison between present findings and the data gathered in other areas would present a true picture of their behavioural pattern and adaptability.

STUDY AREA

The study site lies west of Hassan District, between 12°31′ and 13°33′ N. & 75°33′ and

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76°38′ E. at an altitude of 960 m. It consists mainly of forested hills. The hot season is from March to the end of May and is followed by the southwest monsoon lasting to the end of September. October and November are post-monsoon and December to February are dry months. The mean annual rainfall is 1041 mm; the western part having the heaviest rainfall, upto 2349 mm. Most of the rainfall is from May to October with a peak in July. Rainfall during the southwest monsoon constitutes about 59% of the total.

From the beginning of March the temperature increases steadily. April is generally the hottest month with a mean daily maximum at 19.7°C. During summer, on individual days, it may reach 35°C, but with an advancing Monsoon it falls considerably. Towards the close of the monsoon, there is a slight increase, and a secondary maximum is reached in October. December is generally the coolest with a mean daily maximum of 14°C. The highest maximum temperature recorded at Hassan was 37.8°C. and the lowest minimum 6.7°C. Relative humidity is high during the southwest monsoon and the post monsoon. February and March are the driest months when the relative humidity is less than 35% in the afternoon (Mysore State Gazetteer, Hassan District, 1971).

The bonnets inhabited cultivated coffee (*Coffea arabica* and *C. robusta*) gardens. Though they descended to the ground or coffee plants to feed on, or for other activities like roosting, grooming etc., they occupied large trees meant to protect coffee plants from direct sunlight and these formed an almost continuous forest canopy where primitive forest remnants form part of the shade tree complex as reported for the habitat of *Leontopithecus* (Coimbra Filho & Mittermier 1973).

Methods

The method adopted was that used in earlier studies of bonnets (Rahaman & Parthasarathy 1967 and 1969 a, b) and langurs (Rahaman 1973). Most of the observations were made from hidden perches because the monkeys were initially extremely shy of man. To know the home range and encounters between troops, all the troops were regularly observed throughout the study period. For behaviour within a troop, troop B was chosen.

To distinguish social status, threats resulting in the displacement of or submission by the opponent were recorded. Repeat counts were taken to analyse the group composition. To ascertain their numbers the animals were driven into areas of sparser vegetation where they could be properly counted as they leaped from one tree to another after a short pause, the distance between trees was long enough to prevent an immediate leap. Precautions were taken not to harass them unduly. During counts, dogs were made use of, to prevent them from

Table 1

Date on frequency of observation

From	To	No. of observation days
20-4-72	13-5-72	24
17-5-72	28-5-72	12
2-6-72	25-6-72	24
1-7-72	28-7-72	28
1-8-72	13-8-72	13
18-8-72	30-8-72	13
9-9-72	15-9-72	7
21-9-72	30-9-72	10
3-10-72	23-10-72	21
6-12-72	8-12-72	3
1-1-73	16-1-73	16
27-2-73	4-3-73	6
18-4-73	28-4-73	11
12-7-73	16-7-73	5
10-8-73	19-8-73	10
	Total days	203

hiding on the ground under the cover of coffee plants, as they generally did.

On all other occasions observations were made using binoculars from concealment at 50-100 m. All adult males and females of troop B were individually identified. Table 1 gives the frequency of observations.

Results and discussion

Monkeys studied in various parts of Karnataka exhibited a number of behavioral variants. In this study the effect of man made and naturally occurring disturbances in the environment on monkey life was investigated. Observations on the responses of primates to modifications of their environment may yield interesting information on the adapatability of the species to new or rarely occurring situations and comprehensive studies enable a better understanding of the ecology and adaptive mechanisms of the species and they require investigations in several localities (Washburn & Hamburg 1965). Bonnets of the present study responded differently to natural variations and human interferences.

Human interferences to a large extent were instrumental in behavioral changes in the monkeys of the present study and as such the situation might be regarded as a little unnatural but the study is of importance in that these interferences have become a part of the monkey's life and there is no escape from them.

Three troops with a mean of 40 individuals per troop were located in a 10 km² area (Table 2) as against 14 troops with a mean of 21 per troop in a 25 km² area in Bangalore, Rahaman & Parthasarathy (1967). Though the number of troops per km² was less than that found in other study areas, Sugiyama (1971), the troop size was large and was contradictory to Simond's (1965) findings who recorded larger troops in open lands.

Table 2

Group size and composition of three troops

Troop Index	Adult Male	Adult Female	Juvenile	Baby	Total
A	7	14	11	8	40
B	9	16	10	10	45
C	6	12	9	7	34
Total 3	22	42	30	25	119

Adult male/adult female ratio was 0.526, while that for Bangalore Monkeys was 0.785 (Rahaman & Parthasarathy 1967); South Karnataka 0.94 (Simonds 1965) and Dharwar 0.828 (Sugiyama 1971). In this respect they resembled the Japanese macaque, *Macaca fuscata* (Itani *et al.* 1963) and the rhesus macaque, *M. mulatta* (Southwick *et al.* 1965).

One male associated with 2 to 3 females at a time, while those in Dharwar and South Karnataka consorted with one female (Sugiyama 1971; Simonds 1965) and no consort relation was observed for Bangalore Monkeys.

Adult female/infant ratio was 0.571 as against 0.445 for Bangalore Monkeys suggesting a higher birth rate and a correlation with environmental factors is drawn (Table 10).

They lived as heterogenous, polygamous units like most primates and unlike gibbons which occasionally occur as monogamous society (Carpenter 1940).

As a corollary of cultivation all predators have been exterminated from the study site and bonnets are thriving. The cultivators are striving hard to reduce their numbers but in vain. During the harvest the cultivators take stringent measures to keep the bonnets out of gardens. Use of dogs, fire and crackers was common. Professional trappers were paid for every amputated tail produced in evidence of mon-

keys killed. Several animals were shot every year and a few corpses hung by their tail on high branches to deter other monkeys. Inspite of these measures, the population of monkeys increased. Their population structure was of expanding type having a large number of breeding animals in contrast to a declining one having too few young ones to replace the older ones (Stephen & Lockie 1969). This was mainly because they kept out of harm's way and readjusted themselves to new situations. When a monkey was shot in one section of a coffee estate, the whole troop kept out of it for a long period and on re-entry the monkeys were nervous, fidgety and alert. They were extremely good at concealing themselves behind the barest cover available. Even a baby froze into inactivity and went undetected from a close range. They were afraid of men with guns and never allowed a close approach unless confidence was built up by repeated harmless encounters. When a shot was fired at troop B, two peripheral males took refuge in an *Erythrina* tree and remained concealed for 48 h without moving out even to feed. The third day they stealthily moved away and rejoined the troop.

Neither solitary monkey nor all-male parties were encountered unlike the langur monkey (Jay 1965; Sugiyama & Parthasarathy 1969; Rahaman 1973) and the howler monkey (Carpenter 1940).

Social Rank and Encounters within Troop

The social ranks of members of troop B were studied by recording the frequency of agonistic interactions. Aggressive actions resulting in withdrawal or submission were taken as indicators of relative dominance-subordination of the interacting animals. The method is the same as that used for the pig-tail monkey by Tokuda & Jensen (1968).

The adult bonnet monkeys, especially males, exhibited a linear social ranking during aggressive and submissive interactions as in baboons (DeVore 1965) and the expression became more obvious when the episodes occurred on ground. The dominant male assumed a patriarchal role and prevented disturbances in the troop, reassembled members that strayed away and defended troops, in contrast with the patas monkey (Hall 1967). There was no instance of a peripheral male dominating members of higher ranks.

Dominance was clearly observed when one male approached another and the second male expressed fear or moved away. Relative dominance among most individuals was clear when the troop was kept on the move continuously by one of us (Rahaman), to create tension. Different investigators use different aspects of behaviour as criteria for dominance. Carpenter (1954) and Jay (1965) stressed priority to incentives as the key criterion where the incentives could be food, sex or any other activity. But under uncontrolled conditions the correlations between such incentives and status would be less and hence Hall (1968) concluded that food test was not at all useful even to approximate the dominance relations. Nowlis (1941) correlated between status and age in chimpanzee, which was not applicable to bonnet monkey as the oldest monkey was never the most dominant. Schaller (1963) indicated relation between dominance and size in gorilla; this index detected the bonnet male at the head of rank as the most dominant male was the largest, but the subdominants with further dominance and subordination were not identifiable by size differences. Rowell (1966) concluded that approach and withdrawal episodes were the best indicators to relative status, as followed by us in this study.

Strict hierarchies are prevalent among baboons and macaques (Carpenter 1950, 1954), Hamburg (1968) suggested strict hierarchies as fundamental to all primates and he opined that ground living enhanced the expression of dominance relation and this applied to monkeys of the present study as most of their time spent on ground was in social interactions. Hall (1967) found that male patas monkeys were more concerned with conspecific males than troop defence. Bonnets defended their groups or members against internal and external disturbances and exhibited strong dominance relations.

Sugiyama (1971) observed peripheral bonnet males M_3 and M_4 being dominated by M_6, M_7 and M_8 on being reinforced by M_1 or M_2. No instance of reinforced dominance was witnessed in the present study and this might be due to different method; Sugiyama used wheat or Jowar to determine social ranks under fixed spatial distribution and it is possible that such instances occur in activities involving competition. Each animal expressed its position by behaving differently; the dominant attacking subdominants and the latter screeching or crouching or moving away. However, no true leadership in strict sense existed.

It was the most dominant animal that invariably intervened when less dominant animals quarelled and it was he who vocalised most shrilly, the one to run first to the site of disturbance or danger and often the last to move away from them and the one to call to members which might have strayed away during disturbances.

The extent of intertolerance was more among bonnets of different sex and of same age groups, in that males gave a wider berth to females. Intratroop fights occurred in various contexts and with varying degrees of involvements of combatants. Fights over food, disturbance, and close approach accounted for over 80% and were directed at subadults, juveniles and babies. This is similar to the behaviour of gibbon (Carpenter 1940) and this complicated the issue and arriving at a conclusion was difficult unless a single facet of behaviour was used as indicator.

Individuals quarrelled quite frequently. The quarrels ranged from a few seconds of chase to prolonged vocal and physical attacks lasting about 10 m. The attacked individual was often badly mauled but never actually killed. The attacks were usually one sided and the attacked animal just submitted to it and latter moved to a secluded spot to nurse wounds. Other members of the troop, more often the juveniles and females, approached and groomed it. A wounded animal was groomed more frequently than others and it too reciprocated inspite of its wounds.

On 3.3.1973, a subadult male of troop B was attacked by the dominant male and was seriously wounded in the right flank. The fight lasted four minutes over reasons unknown. The

TABLE 3

FREQUENCY OF WOUNDED ANIMALS BEING GROOMED IN A SINGLE FIGHT

Groomer	Animal Groomed (Wounded male)		reciprocation	
	No. Groomings*	Total time (mt)	No. Groomings*	Total time (mt)
Adult female	3	48	—	—
Juvenile male (1)	1	6	—	—
Juvenile male (2)	1	3	1	1
Juvenile female	1	3	—	—
Female with baby (1)	1	10	1	6
Female with baby (2)	1	17	1	2
Total	8	87	3	9

* With brief breaks.

TABLE 4

FREQUENCY OF ATTACKS ON A NORMAL AND A HARASSMENT DAY DURING 2 HR OBSERVATION (0800 H TO 1000 H)

Date	Attacker	Attacked	Incentive	Result	Remarks
8.1.73	Male A	Male C	Not known	Serious wounds	Harassment day
–do–	Male A	Male J	Blocking way	Slight bite	–do–
–do–	Male D	Male H	Not known	Slight bite	–do–
–do–	Female B	Female D	Direct approach	Vocal & Physical attack	–do–
–do–	Male B	Juvenile	Not known	Chase & bite	–do–
–do–	Female C	Juvenile	Baby harassing	Chase & attack	–do–
4.3.73	Male A	Juvenile	Breaking branch	Vocal & Physical attack	–do–
–do–	Male A	Juvenile	Not known	Serious wounds	–do–
–do–	Male C	Male I	Blocking way	Serious wounds	–do–
–do–	Female A	Juvenile	Not known	Slight wound	–do–
–do–	Male I	Juvenile	Falling bark	Vocal attack	–do–
1.3.73	Male D	Female F	Over food	Attack & bite	Normal day
–do–	Male F	Juvenile	Not known	Slight wound	–do–
4.3.73	Female C	Juvenile	Baby harassment	Slight wound	–do–
–do–	Female B	Juvenile	Close approach	Chase	–do–
–do–	Male D	Male H	Falling bark	Slight wound	–do–

TABLE 5

ANALYSIS OF FIGHTS WITHIN THE TROOP

Incentive	Attacker	Attacked	Result
Food	Dominant male	Peripheral animal	Chase, bite, facial and vocal threats.
Baby harassment	Mother	Juveniles	Chase away, vocal threat and head bobbing.
Close, silent approach	Dominant animal	Peripheral animal	vocal and/or physical attack.
Sudden startle by something falling (more often on ground)	Dominant animal	Peripheral animal in the immediate neighbourhood	Physical attack, often Vocal and gestural.
Branch snapping	Dominant animal	Juveniles	Vocal threat, rarely physical attack.
Direct approach	Dominant animal	Peripheral animal	Head bobbing, vocal threat following attack.
Blocking way	Dominant animal	Peripheral animal	Push aside and/or bite.

wounded male lay on the branch for some time and then moved away further and sat nursing its wounds. An adult female, 3 juveniles and a female with baby groomed him (Table 3).

More displays and fights occurred when the troop was disturbed by human action. On a day when the troop was harassed for a long time the dominant monkeys attacked others at the slightest provocation and even threatened the author (Rahaman). On a normal day, however, there were fewer attacks. Two attacks were noticed on 1.3.73. (a normal day) while on a tense day 5-6 were common (Table 4) in 2 hrs. of observation. This phase of study could not be extended for longer periods without making the monkeys panic and seek refuge on tree tops.

While the adults attacked subadults and juveniles more frequently, the juveniles attacked other juveniles and babies, expressing a certain amount of dominance among themselves. While short fights of demonstrative type occurred without much provocation (Table 5) when the troop was feeding, longer and more serious fights occurred mainly when the animals had settled down to rest.

When a serious fight was in progress, the other individuals suspended their activity and watched the fight. After the fight both combatants settled down to relax for a while before resuming their normal routine, but continuously vocalized for a long time. The dominant male growled while the subordinate uttered soft calls.

If there was a vocal exchange between members of subordinate status, the dominant male vocally reprimanded them; but if the former got into physical combat the dominant physically intervened. If a fight developed between dominant males (A & B) a few peripheral animals approached the attacker, crouching low and screeching from a short distance. The attacker then disengaged and the attacked animal ran away. But if the duel was between an animal of A or B status and a peripheral animal of say, E to I status then, after the disengagement, the attacked animal lay down screeching till the attacker moved away or lost interest.

By the difference in vocalisations it was possible to determine with certainty the status of combatants without actually seeing the combat. If the fight was between two individuals of high rank, the fight was quite long and there were pleading vocalizations by other members of the troop, but if it was between any two members of lower rank then the angry reprimanding growls of the dominant male accompanied by branch shaking could be heard at a distance.

An animal attacked by the most dominant male was most likely to be seriously mauled. The interesting feature of such a duel was that the attacked individual, after running a short distance away, surrendered by crouching down. But on occasions the dominant male, after a short chase, gave up and lost interest, but if the chased animal came back within close range he was attacked again. The intensity of second attack was mainly governed by the time between the first encounter and the second. The juveniles sometimes behaved differently in this context. On being chased they ran away but, after the chaser had stopped, they came back to him smacking lips. This elicited either an attack or grooming by the attacker.

To evade attack by a dominant animal an attacked individual may in turn attack its subordinate if close by; on this the dominant attacker gave up or tried to stop the fight. This was observed only twice.

The dominant males attacked more often during the months when the copulation frequency was high (Table 7) a period coincid-

ing with the rainy season. Their close association with females, either to copulate or take shelter from rain by huddling in groups, prevented the peripheral males' approaching females (Table 6).

TABLE 6

COPULATION AND FIGHT* FREQUENCY ON A 5 DAY OBSERVATION PER MONTH

Period	Dominant male (A & B) no. of mounts	Peripheral male (C to I no. of mounts	No. of attacks by males A & B
Aug. 72	12	31	8
Sept. 72	23	38	18
Oct. 72	17	45	14
Nov. 72	5	42	6
Dec. 72	4	22	2†
Jan. 73	9	19	12
Feb. 73	3	37	9
March 73	5	11	8
April 73	5	15	6
May 73	—	—	—§
June 73	—	—	—§
July 73	7	12	5
Total	90	272	88

* Fights recorded in Table 4 are excluded.
§ No observations made.
† 3 days of observation.

Branches were shaken by dominant males to express anger, announce danger or deter fights. The animal chose a branch not occupied by other members, moved to the extremity and shook it. If the branch was slender it was agitated vigorously; if stout and horizontal, the animal jumped on it and by side stepping changed direction or ran hopping over a distance of 4 to 6 m. Occasionally lopped stumps were also shaken. On rare occasions a relaxing animal reached out to the nearest branch and shook it but less vigorously, the reason for this action is not clear. On occasions a male held one slender branch with both hands and another with legs and rocked his body to and fro to agitate both branches. Branch shaking was not noticed after dark.

Fights appeared to serve five main purposes, i.e. confer dominance; punish miscreants or nonconformists; reinforce social bond; relieve tension; and warn others to refrain from involvements in unpleasant situations.

While a peripheral male or female provoked wrath of a dominant animal in a fight it aroused sympathy in many others and hence fights formed a useful tool in strengthening social bond. Fights formed a complex system covering both detectable and undetectable reasons. The detectable ones were food, baby harrassment, blocking the way, close approach and on being suddenly startled (Table 5).

Branch shaking is reported for gibbon (Carpenter 1940) and bonnets of other areas (Nolte 1955; Simonds 1965; and Rahaman and Partha-

TABLE 7

GROOMING FREQUENCY OVER 5 DAY OBSERVATION PER MONTH AS IN TABLE 6

Period	Self grooming	Social grooming	Mother grooming infant
Aug. 72	16	45	—
Sept. 72	13	58	—
Oct. 72	8	33	—
Nov. 72	20	28	—
Dec. 72*	5	19	—
Jan. 73	11	14	—
Feb. 73	2	18	15
March 73	—	27	28
April 73	7	15	31
May 73†	—	—	—
June 73†	—	—	—
July 73	19	17	12
Total	101	274	86

* 3 days of observation.
† Observation not made.

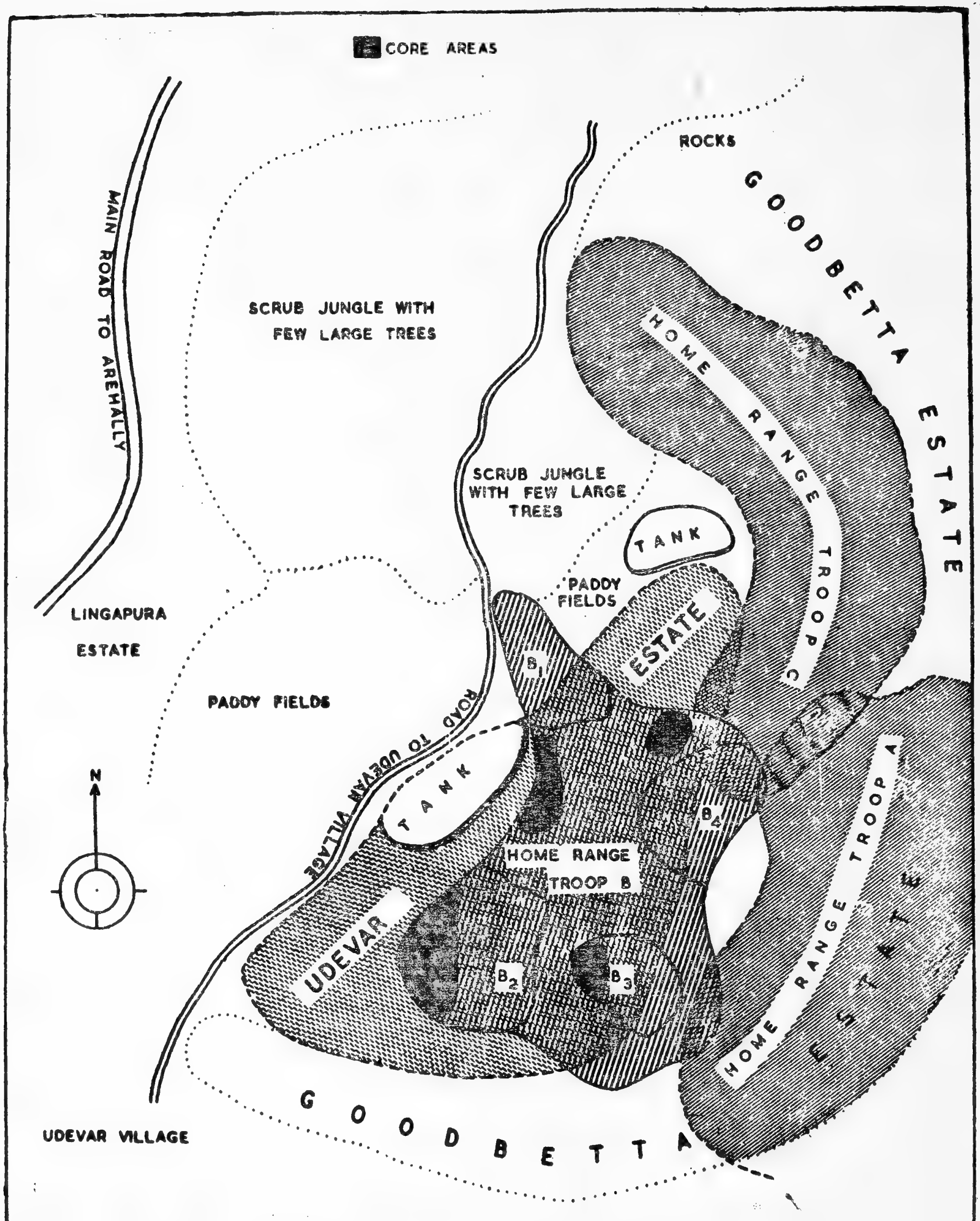

Fig. 1. Home range, sub-zones and core areas of 3 troops in Hassan District, Mysore.

sarathy 1968). In the present study branch shaking occurred with variations not observed elsewhere and no branch was shaken after dark suggesting that it was a means of not only producing sound but also of visual warning. It could also mean that animals could not move and select a branch unoccupied by others after dark.

Home range, core areas and roosting places

Bonnets did not observe territoriality but moved within circumscribed areas as does coati (Kaufman 1962); a trait common to bonnets studied in various sites.

The pattern of daily movement of the three troops indicated restriction of their movement to specific boundaries but occasionally extending it to neighbouring ranges under human interference. The dominant troops occasionally invaded neighbouring ranges, after which they returned to their own range after a short vocal display. There were no serious fights and all troops usually kept within their ranges, (Fig. 1). The daily movement of the troops covered a mean area of about 1 Km^2; the linear extent was about 3 Km, depending mainly on food and physiographic conditions. Troop size did not influence the area covered.

As a result of this pattern of movement the ranges of the three troops overlapped. The range of troop B overlapped with that of A at two points, one to south-west and the other to north-west of troop A range but to south-east of troop C. Likewise the home range of troop C overlapped at one point to north-east with that of troop A and on the other to north-west of range B (Fig. 1).

Maximum overlaps occurred to the north of troop C range. The only source of water available to troop A and C was located here, while the troop B had a tank in the west. But since this tank was close to Udevar road, the troop seldom used it. On the other hand the other tank located in the overlapping zone to the north-east of B range was more or less free of human interference, in that the land was eroded and the terrain difficult for man to negotiate. There were large trees in the area that offered shelter also. In addition the area to the north of troops A and C ranges and north-west of B range was scrub jungle with lantana bushes and the troops kept an eye on the area, the only possible way by which man could approach. The area also had a patch of abandoned paddy field where monkeys went hunting grasshoppers, a rarity in coffee estates.

Table 8

Grooming frequency in relation to age group

Participant	Groomer	Grooms	Self groom
Adult male	97	82	35
Adult female	185	109 plus 86*	47
Juvenile	30	74	19
Baby	2	49 plus 86*	—
Total	314	314 plus 86*	101

* Mother grooming infant.

Though they spent much time on the ground, major activities like feeding, resting and grooming were more frequently performed in tree tops. On a rough estimate they spent about 20 to 25% of their time on ground. Those of other areas spent about 30% of the time on the ground, and those of the high forest of south the about 10% (Sugiyama 1971). This suggested that predator pressure influenced the time spent on ground and that the bonnets of the present study spent more time on ground than true forest animals as there were no predators, but less than urban monkeys as the

habitat in which they lived was semijungle and as they were still in the process of recognizing it as being predator free.

There were fluctuations in the home range mainly influenced by season, food availability and human interference. During the rainy season they stuck to one particular part of the range for a number of days and these areas could be regarded as *subzones*. During summer the excursions were longer than during winter or rains. Troop B had 4 subzones (B 1 to B 4 in Fig. 1) of about equal area; in each of these it spent from 2 to 9 days.

At other times they moved about in the whole range except when rains hindered their daily movement.

Functionally the range was related to the process of reproduction, feeding and safety, and was invariably restricted unless interfered by man. Within the confines of home range the animals appeared more relaxed and readily engaged in normal activities, but once forced out of it, their sole concern was to return to it. No social interactions of amicable type within the troop members were witnessed outside the range and though territories were not defended by bonnets, they did not move about without fixed boundaries.

That the subzones were components of home range was demonstrated by the fact that during summer the troop temporarily split up on occasions and occupied two subzones for a short time but no party left the confines of the home range. When individuals stayed behind in one zone while the others had moved away into another, the dominant male vocalised till there was a reunion.

Within the home range were a few selected places where monkeys spent much of their time. These *core areas,* were selected for the maximum amount of safety they provided. These areas were rich in tall trees and offered a good amount of shade in the lower storey while the canopy provided sunshine. The monkeys moved between lower and upper storeys as they desired. The core areas might or might not hold food trees. While maximum aggressive displays occurred in the feeding areas, friendly displays occurred in core areas. These areas were distributed inside or outside subzones. The ones outside held large trees like *Erythrina, Casuarina, Artocarpus* etc., and were held more during summer; the ones inside held trees like *Derris* whose thick foliage offered shelter against rain and wind and were occupied more during the rainy season. On being evicted from one core area they headed for the next and seldom settled down outside. Sugiyama (1971) noticed 5 stages in the occupancy of home range by bonnets in Dharwar similar to that discussed above.

The extent of home range was 1 to 3 km similar to ranges in Bangalore (Rahaman & Parthasarathy 1969 b). This suggested that there was a certain fixed area required to fulfill the necessities of bonnet troop members as individuals rather than whole troop as a unit; that once this area was occupied there was no further exploitation of the neighbouring land inspite of the absence of monkeys there.

Home range study poses one important question—Why there should be range overlap? If the troops just shifted their respective ranges a bit or shortened them a little, there would be no overlap. The study of troop B suggested a few points of interest. Its range overlapped that of troop A at 2 points and that of C at one point. Exploration of the area to north, south and west of its range did not yield any other troop, though the vegetation was uniform and confluent. If the troop wanted to avoid contact with others, it could just move slightly to north-west and the same ap-

TABLE 9

COMPARISON OF BONNET MONKEYS OF BANGALORE WITH THOSE OF HASSAN

Feature	Bangalore monkeys	Hassan monkeys
Number of troops	14	3
Total area inhabited	25 km²	10 km²
Nature of habitat	Urban	Cultivated coffee gardens
Mean number of adult males per troop	6.0	7.3
Mean number of adult females per troop	7.6	14.0
Mean number of animals per troop	21.1	39.3
Adult male/infant ratio	0.526	0.785
Adult female/infant ratio	0.448	0.571
Home range: Gross area	1 km²	1 km²
linear extent	1 to 3 km	1 to 3 km
Special features	Generally whole area covered throughout the year.	Within the range are sub-zones with restricted movement in different seasons.
Core areas	Few selected ones.	As for Bangalore.
Ovelapping area	About 30% of the total area.	15 to 20% of the total area.
Roosting places	Few selected ones with no special preference during different months.	Special preference for different sites in different seasons.
Movement	Free of seasonal fluctuations, frequent human interference.	Governed by seasonal fluctuations and human interference during harvest.
Feeding	Proffered or stolen items, often discarded garbage.	Exclusively natural and cultivated items.
Social grooming	Almost uniform frequency throughout the year.	Fluctuating with seasons.
Breeding	Peak in October-November, with no selective breeding.	Peak in August-October with dominant male siring most young females during peak.
Interspecific behaviour	None	Associate with a number of other species.

plied for the other two troops. Instead, their range did overlap and they engaged in inter-troop alterations suggesting that overlap was intentional, and this had a few advantages to troops. If the home range was divided into charge zone (overlap zone) and retreat zone (free zone) as suggested by Boughey (1971), it was in the charge zone that one troop met another and engaged in duels. It was in this zone that maximum number of animals participated in aggressive feats and yet remained unscathed by the dominant ones of their troop. The overlap thus provided an opportunity for peripheral animals to engage in fights, express anger etc., which in turn conferred interdominance and the troops became closed societies. The juveniles still in the process of learning here recognised other troops as inaccessible to them and to restrict themselves to their range.

Bonnet monkeys selected large trees at random to roost. But since the core areas held such trees, the sleeping sites were usually located within and were repeatedly used.

Settling down to night's rest was mainly governed by light. During bright days they fed as late as 1800 hr to 1900 hr, but on a cloudy and specially on rainy days they settled down to roost early and the activity started as late as 1000 hr the next morning. They broke up into parties of 2 to 5 and slept, and the congregations were larger during rains. A mother with baby was accompanied by juveniles and subadults who encircled her. Adult males and females formed their own congregations. The dominant male kept vigil from the tree top till dark and then joined an adult party to sleep.

During non-crop season with less harassment by man, they spread out wider but dur-

Table 10

Comparison of birth rate among Hassan and Bangalore monkeys: correlation with environment

Feature	Bangalore monkeys	Hassan monkeys
Adult female/infant ratio	0.448	0.571
Food	Meagre, often discarded and rotting garbage with competition, sometimes even with man.	Plenty, mainly fruits, leaves, flowers and animal matter (insects) no competition.
Harassment	Much by children and dogs.	Harassment by man only during harvest.
Strain	Lot of nervous strain caused by children, dogs and vehicles during progression.	None
Copulations	Often interrupted by dogs and children.	None
Protection	Maximum.	Indiscriminate killing during harvest.
Physical state of animals	Majority weak; suffer from various diseases.	Very healthy and robust.

ing the harvest they settled down on fewer but large trees. While resting, an animal dozed or slept but immediately opened its eyes at the slightest noise. During the rainy season they were silent and formed large parties and huddled closely. Few individuals consistantly selected swaying slender branches for the purpose.

Once they had settled down and it was dark, they were difficult to locate by the beam of a torch. Occasionally they vocalized as late as 2100 h, unlike Bangalore monkeys. These vocalization marked relative position. On waking the next morning or after an afternoon nap, they stretched limbs, yawned a few times and sat motionless surveying the area for some time, before feeding. The juveniles on waking started feeding immediately.

Maximum number of micturitions and defecations occurred in core areas and roosting sites after the animals had settled down to rest after feeding. This might mark zones and prevent invasions by neighbouring troops (Rahaman & Parthasarathy 1969 a).

Movement

The movement of monkeys was influenced by three main factors; food availability; rainfall; human interference.

Food availability: When food was in plenty the movement was restricted. From January to February when coffee was harvested the movement was much less but the animals were sometimes driven out of their range. Occasionally they made long excursions in quest of different items of food.

Rainfall: Heavy rains hindered the movement and feeding. During continuous, light drizzles there were intermittent feeding and resting bouts but the movement was minimum.

Human interference: During harvest, the monkeys were forced to taking shelter in tall trees against gunfire or into leaving the confines of the range.

From March till about the end of November the monkeys moved without human interference. Movement was relatively more during morning and evening hours.

Progression on ground or trees depended mainly on rains and maximum ground progression occurred when the animal took fright and tried to hide under coffee bushes. Two types of ground progression were noticed.

(a) Movement playfully initiated by juveniles by moving away from one section to another followed by others. The animals covered short distances and not in any fixed direction.

(b) Movement started by adult males and females with the dominant male sometimes taking lead. The troop moved in a definite direction; to or from the feeding and sleeping sites. Long distances were covered and monkeys moved in a file under coffee plant cover; long progressions in open areas were avoided and on coming to a path the animals broke up into parties of 2 to 5 and moved into the next section with a short interval of time in between. The party that moved first into the new section scanned the area for presence of danger; other parties walked in slowly.

Out of the 58 instances of ground progression studied 43 times adult males led the party followed by adult females; females with babies; juveniles; remaining adult males brought up the rear. Other 15 times juveniles led the party. The dominant male was found either in the male-party in the lead or to the rear. Juveniles did not strictly adhere to this pattern of movement, but stayed behind for a short while. When the troop was on the move to feeding or roosting sites, the movement was

quick and monkeys often ran, but the movement within one site was slow.

During tree progression this pattern of procession was more or less observed but going ahead of one individual from one tree to another was dependent upon availability of confluent branches. When one animal crossed one tree with ease the other might stop for a while or select a suitable branch before crossing over. Taking lead was thus governed by the availability of suitable avenues and any animal moved ahead first but waited to observe the formation of pattern. However on finding man or dog in the vicinity the animals did not stick to this pattern.

They took horizontal leaps of 8 to 10 m with ease if the branch on which to land, had thick foliage; if it was bare, the animal paused to locate suitable perches. Falling leaps of 10 to 15 m also were common while the vertical leaps covered a maximum distance of 4 to 5 m. The hind limbs propelled the animal and the fore limbs gripped the branch on landing.

Two types of leaps were recorded; leaps without initial 'build up', where the animal on reaching the extremity of a branch stopped a while, scanned the distance and leaped; leaps with initial 'build up', where the animal in its run leaped indiscriminately. The momentum built up in the run carried the animal over long stretches. This mode was resorted to when the animals were bounding away in fear or in chase or in avoiding fights.

While leaping from one branch to another, some monkeys lost footing and fell. Such animals were not rescued by the troop. Three falls from heights of 20 to 25 m were observed but within a few minutes the animals moved to safety by themselves. On one occasion a monkey on losing grip of a branch caught a lower branch in its fall and reached safety. If branches broke under the weight of the animals, they clung to it till touching ground.

During tree progression large chunks of dry bark or decaying stumps of branches were broken and dropped and the area was searched for insects and the like, or the animal just moved ahead. On slanting branches they walked on fours or bipedally and to descend in a hurry they came down head first.

An injured mother followed her baby rather than lead. In general, the troop members did not match their movement with that of mothers with infants but moved away and were later joined by them.

The monkeys were not disturbed, when a section of their habitat was on fire, and they fed only a short distance away. There were more incidence of ground progression during the summer than the rainy season.

Feeding

Bonnets fed on a variety of fruits, flowers, leaves, stems, bark, pith, gum and stilt roots. Main food trees were *Artocarpus lakhucha, A. hirsutus, A. heterophyllus, Erythrina variegata, Eugenia malaccensis, Emblica officinale, Ficus drupacea, Lantana americana, Mangifera indica, Derris glabra, Syzygium cumini* and *Tamarindus indica.* Feeding started around 0700 to 0800 h and concluded around 1800 h.

By inhabiting cultivated gardens they damaged plants and fruits of coffee (*Coffea arabica*), paddy (*Oryza sativa*), orange (*Citrus reticulata*), and cardamom (*Elettaria cardamomum*). The amount of damage is dealt with separately. It was established that females with infants caused the greatest damage, especially in the morning hours. But the monkeys aided in the dispersal of seeds by extruding the swallowed seeds intact.

While feeding was regulated by food availability the rainfall regulated feeding and other activities too. When rains were continuous the monkeys fed and moved during lulls at any hour of the day. They were generally less active in inclement weather.

When food was plentiful they finished feeding by 1200 h and settled down to rest. They supplemented diet with birds' eggs, insects and pupae. While feeding on large trees they were more relaxed than on smaller trees or cultivated crops and spread out wider, contrary to Bangalore monkeys (Rahaman & Parthasarathy 1969), as the crops were protected and the animals apprehended danger in remaining on low trees. Occasionally they located ripe *Artocarpus* fruits and the like by smell; the powerful teeth help them in ripping open the fruits. During progression on trees or ground, crevices, mud moulds etc., were scanned for the presence of insects and the like. Bark of young *Erythrina* saplings was also eaten.

After harvest, they invaded paddy fields freely and searched for grasshoppers. Mushrooms, *Agaricus sp.,* were crushed but not eaten. Sugiyama (1971) reported that bonnets in Dharwar ate *Calotes,* but the animals of this study ate it neither in the laboratory nor in the field. Food was selected by smelling and tasting. Certain items were discarded on smelling, while a few others after smelling and tasting.

While feeding on paddy, the animals twisted a few stalks together and made a high perch to keep out of water. An animal fed on its own faeces while others too shared it. Semen extruded on copulation was eaten by either or both partners and occasionally the others who groomed the female. Water consumption was less as the animals fed on plant products and lived in the shade while those of Bangalore fed on what was proffered or discarded by man with low water content. Latex adhering to hands and muzzle after feeding was got rid of by rubbing it on a branch.

Grooming, mating, maternal behaviour and play

Frequency of grooming is tabulated (Table 7). While there was a decrease in other facets of behaviour during rains, there was an increase in grooming frequency. The percentage of animals offering to be groomed was assessed at 60% of the total number of grooming instances, and out of which the offer was accepted 40 times. Out of the 20 rejections it groomed 15 times. The percentage of groomer volunteering was 40.

A prospective groomer on being rejected, groomed another which provoked a grooming response; in 90% of cases there was reciprocation. Observations on groomer-groomee frequency for all age groups are recorded (Table 8). There was no correlation between grooming frequency and the status of participants.

Grooming frequency between mother and her infant gradually decreased as the baby grew older and then declined considerably around the time of weaning.

In their grooming behaviour, bonnets of the present study differed but little from those of other areas. It was regulated by seasonal variations and two peaks were recorded; one coinciding with the peak in copulations and the other when the babies were 2 to 4 months old.

Copulation frequency was at its peak from August to October, while for Dharwar monkeys from April to September (Sugiyama 1971); for Bangalore monkeys from October to November (Rahaman & Parthasarathy 1969) suggesting environmental factors influencing the onset of breeding period.

Maximum number of copulations occurred at this time as there were larger congregations, precluding infant delivery during rains. Out of the 362 copulatory mounts studied 166 occurred from August to October (Table 6), 197 took place on ground and the rest in trees. During the rainy season the maximum copulations occurred when other activities were restricted and when there were more amicable and hostile interactions. The dominant males were more aggressive during this season owing to restricted activity, a phenemenon not observed in other areas. The aggressive behaviour of males and their closeness to females prevented peripheral males from gaining frequent access to females during this time which also coincided with breeding season, thus resulting in selective breeding.

Hall & DeVore (1965) and Jay (1963) reported that mating pattern in a troop maximised the reproductive success for dominant male. Simonds (1965) did not observe this in bonnet monkeys. The copulations in monkeys of this study were restricted to troop members only unlike the gibbon (Carpenter 1940) which mated with a suitable individual from some other troop. Maximum number of infants were born from January to May.

Babies and juveniles mounted among themselves more frequently than on older ones and this activity bred more familiarity and a stronger bond among them. If this trend was maintained, there could be fewer chances of inbreeding among members of different age groups and consequently between parents and their offsprings and between older and younger siblings.

Maternal instinct and the instinct to safeguard young ones was highly developed.

On December 18, 1973, Shafeequr Rahaman (personal communication) shot a female with an infant sitting close by on an *Erythrina* tree. The female on being hit immediately took hold of a few slender branches and twisted them in a bunch and left the baby in it. Whether the female did this on impulse or it was intentional could not be recorded. The twisted mass formed an ideal cover and a suitable platform for the baby. After leaving the baby, she moved to a distance of about 150 m and sat down in a fork for nearly 50 min and then staggered back to where she had left her baby thus again exposing herself to danger. Before reaching the baby she died and fell. The baby was in the twisted clump till dark but was gone the next morning.

On September 5, 1966 in Kadegurje estate, a monkey trying to cross a tree was shot to collect parasites by the author (Rahaman). The animal was at a height of 40 to 50 m. Being hit, the animal sank low and sat motionless for a while clutching a branch with one hand while the other rested on chest. After a few seconds lapse, the animal swung down but still held the branch and the other hand still rested on its chest. Within a few seconds a small object fell to ground among coffee plants without a thudding sound, then came down the monkey. On approach it was found that the animal was a female with a young baby that must have been delivered a day or two earlier as the vagina was still dilated. Near her lay the baby that had actually fallen just before she fell, with a number of pellets in it. It was obvious that the mother was trying to prevent her baby from slipping down by placing her hand on her chest while she struggled to keep hold on the branch with the other, though mortally wounded. She kept hold on the branch as long as the baby clung to her and released it only after it had fallen. Other monkeys of both sexes fell without any such struggle on being shot.

Mothers with young babies interacted less

with other members but more among themselves. It was the close association of mother with her baby that prevented undue harrassment to it by other monkeys and especially by juveniles.

A female of troop C carried two babies, one about 2 months old and the other about 4 months. These were neither twins nor born to her both suckled at her breast. Contrary to this a female in Bangalore not only discouraged others' babies from clinging to her but also removed them (Rahaman & Parthasarathy 1968).

Juveniles and babies played frequently and the adults sometimes participated. The play of juveniles was more on tree tops but when the babies joined, it was performed more on the ground. To a certain extent mothers tolerated others playing with their babies but reacted if overdone. The dominant male prevented juveniles from overplaying and if a branch broke during play, the former attacked them.

Play was indulged in mainly when the situations were normal and there was no danger close by. Even the babies could appraise situations and either play or be very silent.

There were, few inter troop fights. When troop B was found in the overlap zone the other troops were seen a short distance away in their respective ranges indicating that the troops were aware of the presence of troop B and that there was a certain amount of dominance and subordinate manifestation among neighbouring troops; troops A and C appeared more relaxed in their own ranges and never approached the overlap zones without prior confirmation to the absence of troop B in the area; troop B was thus the most dominant.

On meeting, troop B displaced both troops A and C and troop C invariably displaced troop A emphasising that the large troop size does not make it dominant. The two possible factors conferring dominance are aggression and longer occupancy of the area.

As there were withdrawals no instance of actual physical attack was witnessed as in the case of monkeys of Dharwar (Sugiyama 1971). No direct invasions and replacement of one troop leader by another was seen unlike langurs (Sugiyama 1968). On spotting danger, when one troop gave warning calls, the neighbouring troop immediately reciprocated the call and its members sought safety without actually seeing the source of danger. The message was thus relayed from one troop to another.

When two troops were in close proximity and a shot was fired at one of them, the animals ran aimlessly in any direction and often troops intermingled; but later they separated. Occupancy of neighbouring ranges was advantageous to troops at times of danger, brought about spacing, familiarity with the area and mobilisation of group defence.

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BREEDING HABITS AND ASSOCIATED PHENOMENA IN SOME INDIAN BATS

Part V—*Pipistrellus Dormeri* (Dobson)—Vestpertilionidae[1]

A. MADHAVAN[2]

Pipistrellus dormeri collected from Nanded, Maharashtra State, India has no restricted breeding season, but breeds all the year round. The females experience postpartum oestrus and there is a quick succession of pregnancies. Pregnancy may be unilateral or bilateral and not more than one embryo is carried in the uterine cornu during a given cycle. There is an uneven sex ratio with the females outnumbering the males in the adult stage although the sex ratio during juvenile life is balanced.

INTRODUCTION

Detailed reviews of the literature on the breeding habits of bats have been given in earlier communications in this series of papers (Madhavan 1971; Gopalakrishna & Rao 1977). Among the Indian species of vespertilionids the details of the reproductive behaviour have been reported only in *Scotophilus temmincki, S. wroughtoni* (Gopalakrishna 1947, 1948, 1949) and *Pipistrellus ceylonicus chrysothrix* (Madhavan 1971, Gopalakrishna & Madhavan 1971). Although both these species have an annual reproductive cycle the exact breeding season is different. *Scotophilus temmincki* (Gopalakrishna 1947, 1948, 1949) comes to heat in the middle of March when copulation occurs, and this is immediately followed by pregnancy. The young are delivered towards the end of June or early in July. *Pipistrellus ceylonicus chrysothrix* (Madhavan 1971; Gopalakrishna & Madhavan 1971) breeds in the rainy season in and around Nanded in Maharashtra. This species undergoes copulation during the first week of June and the inseminated spermatozoa, which are stored in the female genital tract, fertilize the ova released in the second week of the following July. Deliveries in the colony take place between the last week of August and the second week of September. The foregoing account and the observations on the biology of several Indian vespertilionids (Brosset 1962 a, b, c, 1963) reveal that there is no common breeding pattern even among Indian vespertilionids.

A detailed study of the breeding habits of *Pipistrellus dormeri* has been undertaken because this bat exhibits features not noticed in any Indian vespertilionid so far studied but resembles the Indian emballonurid bat, *Taphozous longimanus* (Gopalakrishna, 1954, 1955) in several respects.

MATERIAL AND METHODS

The specimens of *Pipistrellus dormeri* were collected at random from old houses in and around Nanded, Maharashtra. The specimens were collected during the period between February 1965 and 30th May 1970 in such a manner that every calendar month is represented by one collection or more. Altogether 673 spe-

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cimens were studied for the present report. The body weights were taken with a spring balance and the weights of the sucklings attached to the teats of the mother and those of the young ones which had accidentally dropped from their mothers' breasts were taken with a chemical balance. Body measurements and the length of the testes were recorded. The characters of the external genitalia, the condition of the mammary teats in the females and the position of the testes and the condition of the penis in the males were also recorded. The genital organs and the accessory reproductive structures were dissected out and fixed in different fixatives. The tissues were processed in the usual manner and the sections were stained with Ehrlich's haematoxylin and eosin.

A detailed collection diary showing the description of each specimen was maintained. Table 1 gives the summary of the collection diary and Table 2 gives the monthwise collection of the specimens.

Observations and discussion

1. General remarks on *Pipistrellus dormeri*.

Pipistrellus dormeri is a small bat that roosts during the day time inside crevices in the wooden frames of doors, rafters in the ceiling or below the tiles of the roof of houses. The animal lies with its ventral surface applied to the object to which it clings either with head up or down. Each roost has about three to six specimens which remain deep inside the crevices and they can be evicted out of the crevices by fumigating the crevices with tobacco smoke. Normally the males come out first. This indicates that the males probably occupy the peripheral part of the roosts. The fur on the dorsal side of the body is light brown and that on the ventral side is white. There is a white streak on each side on the dorsal surface at the flank between the patagium and the trunk.

The body weight of the adult male and that of the adult nonpregnant female ranges from 6.0 to 7.0 g; average length of the fore-arm 3.6 cm; wing-span 24.0 cm; and head length 1.7 cm. A single large incisor is present on either side of the upper jaw.

Although *Pipistrellus dormeri* often lives in association with other bats such as *Pipistrellus ceylonicus, Pipistrellus mimus mimus* and *Hipposideros fulvus fulvus* the different species remain in small isolated groups in the same house. The males and females live together throughout the year, there being no sexual segregation at any time. The newly born young ones are naked and its skin darkly pigmented.

2. Breeding habits

A persual of the collection diary and table 1 shows that pregnant females occur in all the months of the year. This leads to the conclusion that *Pipistrellus dormeri* does not have a sharply restricted breeding season but breeds throughout the year.

The adult females collected during any calendar month were at various stages of sexual activity, and the pregnant females collected during any month carried conceptuses at different stages of development as revealed by the differences in the size of the uterine swellings in different females.

Each female becomes pregnant more than once in an year and each female experiences quick succession of pregnancies as revealed by the fact that several females which were collected during different calendar months of the year were not only in lactation and carried young at the breast, but also showed pregnant uterine cornua on dissection.

Females in lactation were collected during all the months of the year except February

TABLE 1

SUMMARY OF COLLECTION DIARY

Date	Male				Female								Grand Total
	Immature		Adult	Total	Immature		Adult					Total	
							Nonpregnant	Pregnant			Lactating		
	Attached	Free			Attached	Free		Right cornu	Left cornu	Both cornua			
1	2	3	4	5	6	7	8	9	10	11	12	13	14
5-1-70	–	–	2	2	–	–	–	–	–	–	–	–	2
6-1-69	1	2	5	8	–	–	3	1	1	–	2	7	15
8-1-68	–	–	1	1	–	–	4	–	–	3	–	7	8
8-1-70	–	–	1	1	–	–	4	–	1+1*	1	–	7	8
15-1-68	–	–	1	1	–	–	–	–	–	–	–	–	1
21-1-68	–	–	2	2	–	–	–	–	–	1	–	1	3
24-1-69	–	–	1	1	–	–	3	–	–	2	–	5	6
25-1-70	–	–	2	2	–	–	4	–	–	3	–	7	9
28-1-68	–	–	3	3	–	–	–	1	2	4	–	7	10
2-2-69	–	–	1	1	–	–	–	–	–	2	–	2	3
2-2-70	–	–	3	3	–	–	1	1	–	3	–	5	8
3-2-69	–	–	1	1	–	–	1	–	–	4	–	5	6
6-2-65	–	–	–	–	–	–	–	–	–	1	–	1	1
8-2-70	–	–	1	1	–	–	–	3	2	5	–	10	11
11-2-68	–	–	3	3	–	–	–	2	3	1	–	6	9
13-2-66	–	–	1	1	–	–	–	1	1	2	–	4	5
15-2-69	–	–	1	1	–	–	1	–	1	6	–	8	9
16-2-70	–	–	1	1	–	–	–	5	–	7	–	12	13
17-2-68	–	–	–	–	–	–	2	–	–	1	–	3	3
21-2-70	–	–	3	3	–	–	–	1	8	–	–	9	12
28-2-69	–	–	4	4	–	–	–	–	7	1	–	8	12
28-2-70	–	–	3	3	1	–	–	3	4	1	–	9	12
2-3-68	–	–	1	1	–	–	1	2	5	–	–	8	9
2-3-70	–	–	2	2	–	–	–	–	4	–	–	4	6
7-3-69	–	–	1	1	–	–	–	–	–	–	–	–	1
8-3-68	–	–	1	1	–	–	–	2	3	–	–	5	6
9-3-70	–	–	1	1	–	–	–	–	–	–	–	–	1
17-3-68	–	–	2	2	–	–	–	2	1	–	–	3	5

1	2	3	4	5	6	7	8	9	10	11	12	13	14
20-3-69	–	–	1	1	–	–	–	1	1	–	–	2	3
22-3-70	–	–	1	1	–	–	1	–	4	–	–	5	6
25-3-70	2	–	1	3	–	1	–	–	1+1*	–	3	6	9
27-3-68	–	–	–	–	1	–	–	11	–	–	1	13	13
27-3-69	–	–	–	–	1	–	1	3	–	–	2	7	7
29-3-68	–	–	1	1	1	–	–	–	–	1*	1	3	4
3-4-69	–	–	1	1	–	–	–	–	–	–	–	–	1
5-4-69	–	–	1	1	–	–	2	–	–	–	–	2	3
5-4-70	–	2	1	3	1	–	–	1	–	2	–	4	7
10-4-66	–	–	–	–	1	–	–	–	–	–	1	2	2
12-4-69	–	–	2	2	1	–	–	2	–	1	1	5	7
13-4-70	–	1	2	3	–	1	–	–	–	3	–	4	7
19-4-69	–	–	1	1	2	–	–	1	–	–	2	5	6
27-4-70	–	2	–	2	–	–	–	2	1	–	1	4	6
4-5-70	1	–	–	1	1	2	1	–	2	–	–	6	7
15-5-65	1	–	2	3	–	–	1	1	–	–	1	3	6
20-5-66	–	–	2	2	–	–	–	–	–	–	–	–	2
20-5-70	–	1	2	3	–	–	–	1	–	–	3	4	7
26-5-66	–	–	2	2	–	–	–	–	1	–	–	1	3
27-5-66	–	–	1	1	–	–	–	–	–	1*	–	1	2
30-5-70	–	–	3	3	–	–	1	–	–	–	–	1	4
2-6-69	–	–	1	1	–	–	3	–	–	–	–	3	4
16-6-68	–	–	–	–	–	–	1	–	–	1	–	2	2
17-6-68	–	1	3	4	–	–	–	–	1	–	–	1	5
22-6-68	3	–	4	7	1	–	–	2+3*	–	–	–	6	13
22-6-69	–	–	2	2	–	–	–	2	2	2	1	7	9
14-7-69	–	–	2	2	1	–	–	1	2	–	2	6	8
17-7-68	–	1	1	2	–	–	1	5+1*	–	–	–	7	9
23-7-67	1	–	1	2	1	1	–	2	–	–	2	6	8
27-7-69	–	–	2	2	–	–	–	–	2	1	–	3	5
28-7-68	–	–	3	3	–	–	–	–	1	–	–	1	4
30-7-65	1	–	–	1	–	–	–	–	1	–	2	3	4
2-8-68	–	–	–	–	–	–	–	1	–	–	–	1	1
3-8-69	–	1	1	2	–	–	1	1	4	–	1	7	9
6-8-69	–	–	1	1	1	–	–	1	1	1	1	5	6
11-8-69	–	1	1	2	–	–	–	–	4	–	–	4	6
14-8-65	–	–	–	–	–	–	–	–	1	–	–	1	1
19-8-69	2	–	1	3	1	–	–	–	–	1	3	5	8

1	2	3	4	5	6	7	8	9	10	11	12	13	14
24-8-69	–	–	–	–	–	–	–	1	4	–	–	5	5
2-9-69	–	2	1	3	–	–	–	–	4+1*	–	1	6	9
3-9-67	–	–	1	1	–	1	–	3	2	–	–	6	7
10-9-69	–	–	1	1	–	–	–	–	–	–	–	–	1
12-9-69	–	–	–	–	1	4	–	–	–	1*	1	7	7
15-9-68	–	2	1	3	1	3	1	–	3*	–	1	9	12
16-9-69	–	1	3	4	–	–	1	1*	1*	–	–	3	7
20-9-68	–	1	3	4	–	1	1	–	3*	–	2	7	11
21-9-69	1	2	3	6	–	1	3	2	–	3*	5	14	20
28-9-67	1	–	–	1	–	–	1	1	1	–	1	4	5
29-9-69	–	–	–	–	–	2	–	1+3*	–	–	1	7	7
5-10-69	1	2	1	4	–	–	–	1	2*	–	4	7	11
10-10-69	–	2	3	5	–	1	2	1+1*	–	1*	4	10	15
15-10-69	–	–	2	2	–	1	5	–	–	1+1*	–	8	10
28-10-69	–	–	2	2	–	–	3	–	–	–	1	4	6
7-11-65	–	–	1	1	–	–	–	–	–	–	–	–	1
13-11-68	–	–	1	1	–	–	6	–	–	1	–	7	8
13-11-69	–	–	2	2	–	1	1	–	–	–	1	3	5
16-11-67	–	–	–	–	–	–	3	1	–	2	–	6	6
17-11-68	–	–	1	1	–	–	2	–	–	–	–	2	3
20-11-68	–	–	2	2	–	2	2	–	–	2	–	6	8
22-11-69	–	–	1	1	–	3	–	–	1	4	–	8	9
23-11-68	–	–	1	1	–	1	3	–	–	–	1	5	6
29-11-69	–	–	2	2	–	–	5	–	–	2	–	7	9
4-12-68	–	–	1	1	–	–	1	–	–	–	–	1	2
11-12-69	–	–	3	3	–	1	–	–	–	3	–	4	7
12-12-68	–	–	1	1	–	1	6	–	–	–	–	7	8
17-12-67	–	1	2	3	–	–	2	–	–	5	1	8	11
18-12-68	–	–	1	1	–	–	4	–	–	–	–	4	5
19-12-69	–	–	2	2	–	–	3	–	–	1	–	4	6
21-12-68	–	–	1	1	–	–	6	–	–	–	1	7	8
25-12-69	–	–	5	5	–	–	2	–	–	–	–	2	7
26-12-68	–	–	1	1	–	–	5	–	–	–	–	5	6
29-12-67	–	–	1	1	–	–	2	1	1	3	–	7	8
29-12-69	–	–	3	3	–	–	5	–	–	–	1	6	9

* Specimens marked with an asterisk were also in lactation.

when no females in lactation could be collected. However, this does not in any way violate the conclusion that females in lactation occur throughout the year since a suckling young which had become accidentally detached from the mother was obtained in February. Apparently it was an accident that female with sucklings were not collected in February. The percentage of pregnancies in only one uterine cornu is higher than those which carry pregnancy in both the cornua in all the months except January, November and December where the situation is reversed. The percentage of pregnant females in the total population of females was higher during the months of February, March, June, July and August than during the rest of the year. There is greater percentage of females in postpartum pregnancy during September than in any other month.

In all the cases of unilateral pregnancy the contralateral ovary and the uterine cornu presented a typically an oestrous condition.

The adult testis exhibited spermatogenetic activity during the entire year.

Most of the bats, both tropical and temperate species, have a strict reproductive periodicity and breed in a sharply defined season (Baker & Bird 1936; Wimsatt 1942, 1944; Gopalakrishna 1947, 1948, 1949; Ramaswamy 1961; Madhavan 1971). Very few species have been known to breed more than once a year (Matthews 1941; Gopalakrishna 1964; Golapalakrishna & Chaudhary 1977; Gopalakrishna *et al.* 1975). Unrestricted continuous breeding throughout the year has been reported to occur in *Desmodus rotundus murinus* (Wimsatt & Trapido 1952) and *Taphozous longimanus* (Gopalakrishna 1954, 1955). *Pipistrellus dormeri* is unlike all Indian vespertilionids so far studied but resembles the Indian emballonurid bat *Taphozous longimanus* in having an unrestricted breeding season, and in experiencing quick succession of pregnancies with postpartum oestrus.

TABLE 2

MONTHWISE COLLECTION OF SPECIMENS

Month	Male	Female	Total
January	21	41	62
February	22	82	104
March	14	56	70
April	13	26	39
May	15	16	31
June	14	19	33
July	12	26	38
August	8	28	36
September	23	63	86
October	13	29	42
November	11	44	55
December	22	55	77

3. Sex ratio

Table 2 reveals that in a total of 673 specimens collected at random for a period of over five years 485 were females and 188 males giving a sex ratio of approximately 388 males for one thousand females. It is significant that among the 32 sucking young attached to mother's teats there were 17 females and 15 males giving nearly even sex ratio during the early juvenile stage. Evidently, there appears to be a preferential mortality of the males as the young ones reach the adult stage resulting in the unbalanced adult sex ratio in this species. An uneven sex ratio with females predominating the males has been reported in several species of Indian bats (Abdulali 1949; Gopalakrishna 1947, 1945; Ramaswamy 1961; Brosset 1962 a, b, c; 1963; Madhavan 1971; Gopalakrishna & Madhavan 1970; Gopalakrishna & Chaudhary 1977; Gopalakrishna & Rao 1977; Gopalakrishna & Madhavan 1977;

Madhavan *et al.* 1978). *Taphozous melanopogon* (Abdulali 1949) appears to be the only Indian Chiroptera in which there appears to be a predominance of males.

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CRITICAL TAXONOMIC NOTES ON SOME SPECIES OF *CASSIA* LINN. FOUND IN INDIA[1]

VIJENDRA SINGH[2]

(*With three text-figures*)

About thirty species of *Cassia* Linn. (Caesalpiniaceae) are known to occur in India. The present paper deals with the correct identity, nomenclature, taxonomic status and descriptive notes on thirteen most confusing species of the genus. The keys for identification of closely related taxa are given along with the figures of important parts of taxonomic value and distribution of the taxa concerned.

While studying the herbarium specimens of the species of *Cassia* Linn. found in India and the literature dealing with the genus, it was noted that inspite of many recent publications on the genus *Cassia* Linn. (Ali & Quraishi 1967; Bentham 1871; Brenan 1958; Britton 1930; Chatterjee 1960; de Wit 1955; Panday 1971 and Steyaert 1950 etc.), some species of *Cassia* Linn. like *C. italica* (Mill.) Lem. ex Andrews, *C. obtusifolia* Linn. and *C. tora* Linn., *C. javanica* Linn. and *C. nodosa* Buch.-Ham. ex Roxb., *C. mimosoides* Linn. and its varieties, *C. surattensis* Burm. f. and *C. suffruticosa* Koen. ex Roth and *C. pumila* Lamk., have been mixed up in Indian herbaria and literature. Besides misidentification of several taxa and considering a quite different taxon conspecific with other related taxa, there are cases in some Indian herbaria where two specimens of same field number, identified as one species, actually belong to two different taxa. Hence, it seems worth while to publish the present note, based on detailed critical taxonomic and experimental studies on the genus *Cassia* Linn.

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1. **Cassia italica** (Mill.) Lem. ex Andrews, Fl. Pl. Anglo-Egypt. Sudan 2: 117. 1952.

Brenan (1958) recognised three subspecies under this taxon namely *italica, micrantha* and *arachioides,* and mentioned that all the Indian material belongs to subsp. *micrantha* Brenan. He has distinguished these infraspecific taxa on the basis of following characters:

Petiole 1-3.5 cm long. Racemes 6-23 cm long, longer or equal to subtending leaves. Sepals 8-13 mm long. Petals 9-20 mm long. Large anther 8-14 mm long; middle one 4-6 mm long and staminodes 1.5-2.5 mm long. Distributed in Persia, Arabia, Israel, Egypt, Ethiopia, Sudan, Nigeria, West T. Africa, North Africa and Punjab and Sind .... subsp. *italica*

Petiole 1-2.5 cm long. Racemes 2-8 cm long, smaller than subtending leaves. Sepals 5-8 mm long. Petals 8-9 mm long. Large anther 5.5-6 mm long; middle one 2.5-3.5 mm long; staminodes 1.25 mm long. Distributed in Ethiopia, British Somaliland, Uganda, Kenya, Tanganyika, Bechuanaland, S. Africa, Pakistan and India ...... subsp. *micrantha*

Petiole 0.3-1.2 cm long. Racemes 7-22 cm long, longer than subtending leaves. Sepals 8 mm long. Petals 10-12 × 5-6 mm. Large anther 8 mm long; middle one 2.5-3 mm long and staminodes 1 mm long. Distributed in S. Africa .. subsp. *arachioides*

It is evident from the diagnostic characters mentioned above that they are greatly over-

lapping and are not correlated with one another. The character, that the racemes are shorter than subtending leaves, can be taken as a base for distinguishing subsp. *micrantha* from the other two subspecies. The present study on the Indian material of *C. italica* (Mill.) Lem. ex Andrews reveals that this character also does not hold good as there are different degrees of relationship between the length of racemes and their subtending leaves. The length of flowering and fruiting racemes is much variable even in the same plant. Brenan's work indicates that he has taken the flowering racemes into consideration, while classifying these taxa. A close experimental study indicates that the length of leaves, racemes, sepals, petals and anthers etc. varies greatly in different regions of the same plant at different times. The racemes, shorter than subtending leaves in flowering state, exceed the leaves in fruiting stage or become at least as long as the leaves, if there are no biotic interferences. The Indian plants also vary in indumentum, size and shape of leaves and in general appearance. But, these variants do not show any distinct distribution and Brenan (1958) has himself admitted great variants in the size of leaves, racemes and floral parts in subsp. *italica.* About eighty per cent of the Indian material, definitely, comes under *C. italica* (Mill.) Lem. ex Andrews proper and rest twenty per cent is doubtful as the specimens have been preserved in a very young flowering stage and some are not in good condition to make comments on them. It seems appropriate to recognize the occurrence of proper species, i.e. *C. italica* (Mill.) Lem. ex Andrews in India (Fig. 1) and not subsp. *micrantha* as mentioned by Brenan (1958). Further experimental studies on the validity of Brenan's infra-specific taxa are under progress and in near future, I shall be able to throw more light on this problem.

The synonymy and distribution of the taxon is as follows:

CASSIA ITALICA (Mill.) Lem. ex Andrews, Fl. Pl. Anglo-Egypt. Sudan 2: 117. 1952.

Senna italica Mill. Gard. Dict. ed 8. no. 2. 1768.

Cassia senna Burm. f. Fl. Ind. t. 33. f. 2. 1768 non Linn. 1753).

C. aschrek Forsk. Fl. Aegypt.—Arab. 86. 1775.

C. obtusa Roxb. Hort. Beng. 31. 1814 nom. nud.

C. obovata Collad. Hist. Cass. 92. t. 15 A. 1816 nom. illegit.

C. obtusata Heyne in Arzneyk. Gewachse 9: t. 43. 1825.

Senna obtusa Roxb. Fl. Ind. 2: 344. 1832.

Cassia obovata var. *genuina* Bischoff in Bot. Zeit. 8: 882. 1850.

C. obovata var. *obtusata* (Heyne) Bischoff in Bot. Zeit. 8: 883. 1850.

Senna obovata (Collad.) Batka var. *genuina* Batka in Monogr. Cassien Gruppe Senna 46. 1866.

S. obovata (Collad.) Batka var. *pilosa* Batka in Monogr. Cassien. Gruppe Senna 33, 49. 1866.

Distribution: West T. Africa, North Africa, Ethiopia, Sudan, Nigeria, Israel, Egypt, Iran, Arabia, Pakistan and India.

2. **Cassia obtusifolia** Linn. Su. Pl. 1: 377. 1753.

AND

C. tora Linn. Sp. Pl. 1: 376. 1753.

C. obtusifolia L. resembles closely *C. tora* Linn. and hence, in most of our Indian floras and herbaria, they have been mixed up. Bentham (1871) treated the former under *C. tora* Linn. and this concept was followed by many other workers like Fawcett & Rendle, 1910-36; Baker 1878; Maheshwari, 1963. Prain (1897) separated *C. obtusifolia* L. and *C. tora* L. on the basis of one and two glands respectively on the rachis between one or two lowest pairs of leaflets. The same concept was followed by de Wit (1955). Recently, Brenan (1958) pointed out that some African and American specimens of *C. obtusifolia* Linn. have two glands on the rachis and this may

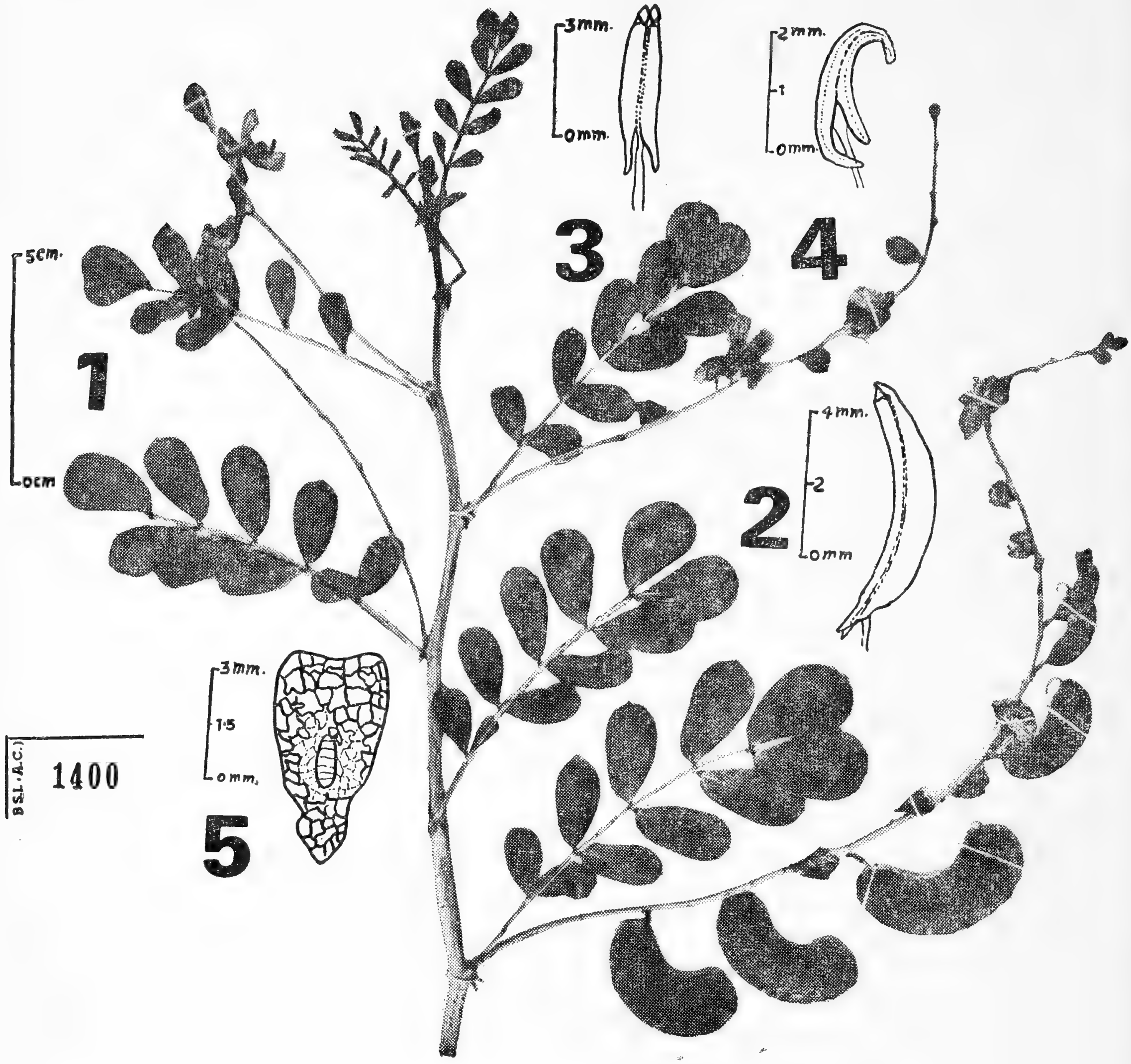

Fig. 1. *Cassia italica* (Mill.) Lem. ex Andrews—1. Flowering and fruiting twig; 2. Large anther; 3. Small anther; 4. Staminodes; 5. Seed.

lead to confusion. He mentioned two more characters based on the shape of large anthers and size of seed-areole to distinguish these two species. A close examination of Indian material reveals that the gland-character is not constant. Both the species may have one or two glands and resemble very closely in most of the morphological characters. However, the following characters, not given due consideration by the earlier workers, are of much taxonomic value to recognize the existence of the two species in India.

Three longer anthers distinctly necked at the apex and rest four rounded. Seed-areole slit-like, narrow, not more than 1 mm wide, never extending upto hilum. Testa slightly muricated, not distinctly veined (Fig. A_3, A_4) .... *C. obtusifolia*

All the seven anthers rounded at the apex. Seed-areole broad, 1.5-2 mm wide, always extending upto hilum. Testa not muricated, but distinctly veined. (Fig. A_1, A_2) .... *C. tora*

The synonymy and distribution of the taxa are as follows:

A. Cassia obtusifolia Linn. Sp. Pl. 1: 377. 1753.
- *C. toroides* Roxb. Hort. Beng. 31. 1814 nom. nud.
- *Senna toroides* Roxb. Fl. Ind. 2: 341. 1832.
- *Cassia tora* Linn. var. B. Wt. & Arn. Prod. Fl. Pen. Ind. Or. 291. 1834.
- *C. tora* sensu Baker in Hook. f. Fl. Brit. Ind. 2: 263. 1878 in part (non Linn. 1753).
- *C. tora* L. var. *obtusifolia* (L.) Haines, Bot. Bihar & Orissa 304. 1922.

Distribution: Native of America; distributed in tropical regions of the world except Polynesia and Australia.

B. Cassia tora Linn. Sp. Pl. 1: 376. 1753.
- *C. sunsub* Forsk. Fl. Aegypt.—Arab. 86. 1775.
- *C. tala* Desv. in Journ. Bot. 3: 73, t. 73. 1814.
- *C. gallinaria* Collad. Hist. Cass. 96. 1816.
- *C. humilis* Collad. Hist. Cass. 96. 1816.
- *Senna tora* (L.) Roxb. Fl. Ind. 2: 340. 1832.
- *Cassia regeonii* Ghesq. in Rev. Bot. Appliq. 14: 238. 1934.

Distribution: Native of America; distributed in Africa, Arabia, Pakistan, India and eastwards to Polynesia.

3. **Cassia javanica** Linn. Sp. Pl. 1: 379. 1753.

AND

C. nodosa Buch.-Ham. ex Roxb. Fl. Ind. 2: 334. 1832.

These two species resemble closely in flower and fruit characters. Baker (1878) suggested that the former may be reduced to a variety of *C. nodosa* Buch.-Ham. ex Roxb. This concept, however, has not been followed by recent workers like de Wit (1955), Ali & Quraishi (1967). They have failed to find out some more constant characters of taxonomic value. Ali & Quraishi (1967) have separated the two species merely on basis of the size of leaflets, i.e. leaflets 6 cm long and acute in *C. nodosa* Buch.-Ham. ex Roxb. and less than 6 cm long in *C. javanica* Linn. The present study shows that, undoubtedly, these taxa are quite distinct and can be separated by the following characters:

Leaves upto 15 cm long; rachis not terete; leaflets not more than 10 pairs, not exceeding 2.5 × 1.3 cm; basal lobe of the stipules acute, much produced downwards; upper lobe acuminate, never aristate. Flowers long pedicelled (pedicel upto 2 cm long), in racemes, borne on the entire length of mother axis. Connective of the dorsifixed anthers produced into a mucro at the apex; anther-lobes rather distinct (Fig. A_5, A_8) .... *C. javanica*

Leaves always more than 18 cm long; rachis terete; leaflets more than 12 pairs, always exceeding 2.5 × 1.3 cm, often retuse or emarginate. Flowers short pedicelled (pedicel not exceeding 1.5 cm in length), in corymbs, borne at the distal end of mother-axis. Connective of dorsifixed anthers not produced into a mucro; anther-lobes not so distinct. (Fig. A_6, A_9) .... *C. nodosa*

The synonymy and distribution of the taxa are as follows:

A. Cassia javanica Linn. Sp. Pl. 1: 379. 1753.
- *C. bacillus* Gaertn. Sem. 2: 313. 1791; Roxb. Fl. Ind. 2: 338. 1832.

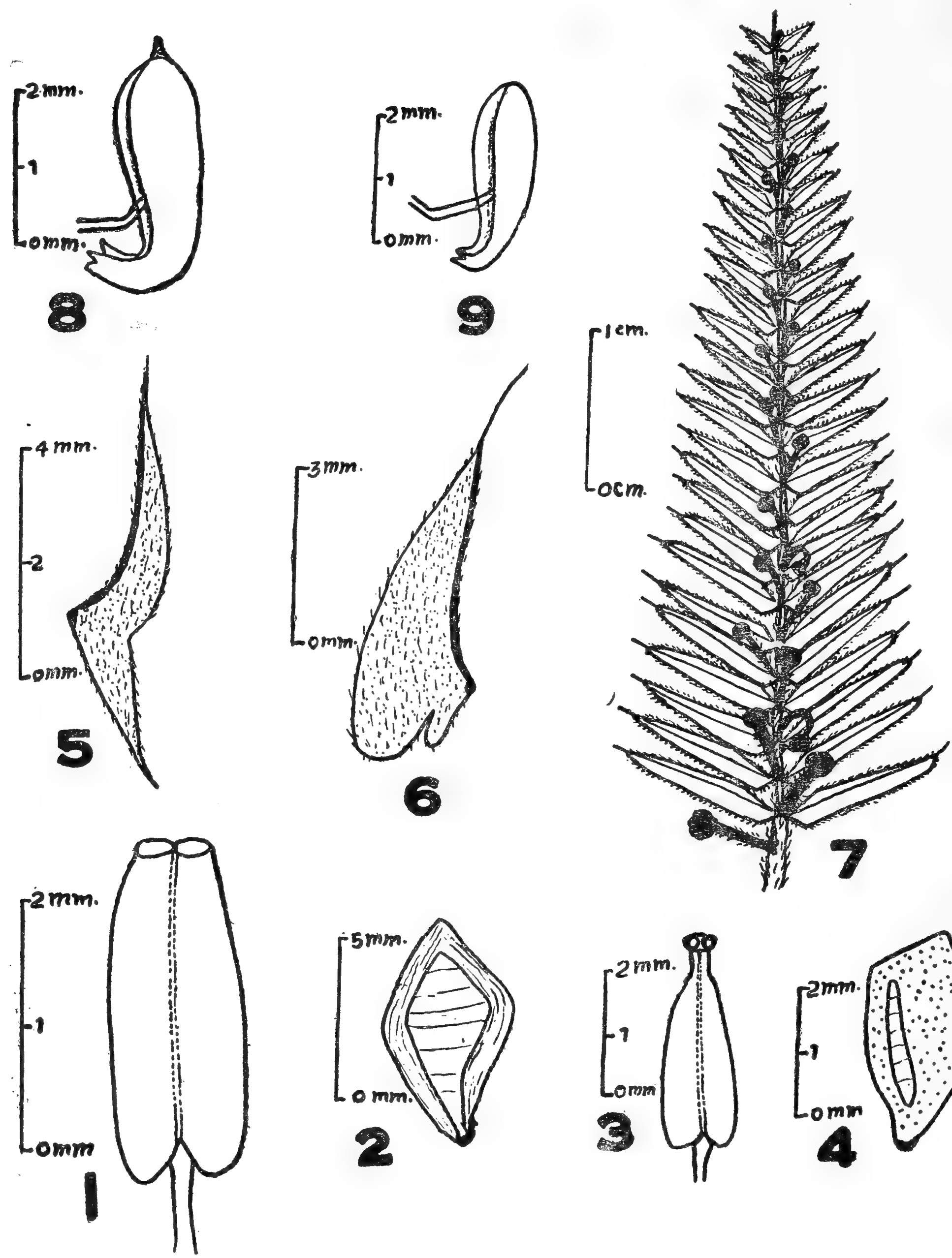

Fig. 2. *Cassia tora* Linn. — 1. Large anther, 2. Seed; *C. obtusifolia* Linn. — 3. Large anther, 4. Seed; *C. javanica* Linn. — 5. Stipule, 8. Dorsifixed anther; *C. nodosa* Buch.-Ham. ex Roxb. — 6. Stipule, 9. Dorsifixed anther; *C. pumila* Lamk. — 7. Leaf.

Distribution: Native of Sumatra and Java, also occurs in eastern India. Planted in gardens and road-sides in many countries.

B. C. NODOSA Buch.-Ham. ex Roxb. Fl. Ind. 2: 334. 1832.

Distribution: Eastern Himalaya to Borneo. Cultivated in the gardens of many countries.

4. **Cassia mimosoides** Linn. Sp. Pl. 1: 379. 1753 and its varieties.

Baker (1878) distinguished three varieties under *C. mimosoides* Linn. namely *dimidiata* (Ham. ex Roxb.) Baker, *wallichiana* (DC.) Baker and *auricoma* (Grah. ex Benth.) Baker. He considered *C. leschenaultiana* DC. as a synonym of his var. *wallichiana*. Prain (1897) pointed out that var. *wallichiana* (DC.) Baker consists of two distinct elements, one is var. *wallichiana* (DC.) sensu Baker and other is *C. leschenaultiana* DC. and advocated the separation of the latter as a species, distinct from var. *wallichiana* (DC.) Baker. More recently, Ghesque (1932) described a species *C. hochstetteri* Ghesq., which is the same as var. *dimidiata* (Ham. ex Roxb.) Baker [based on *Senna dimidiata* Ham. ex Roxb. (1832), non D. Don, 1825]. Steyaert (1950) raised var. *wallichiana* (DC.) Baker and var. *auricoma* (Grah. ex Benth.) Baker to the rank of species, i.e. *C. wallichiana* DC. and *C. auricoma* (Grah. ex Benth.) Steyaert. Again, de Wit (1955) reduced *C. auricoma* (Grah. ex Benth.) Stey. to the varietal rank and transferred it to *C. leschenaultiana* DC. instead to *C. mimosoides* Linn. Ali & Quraishi (1967) further transferred *C. auricoma* (Grah. ex Benth.) Stey. as a variety of *C. wallichiana* DC., as it is more related to it. Ohashi (1975) considered *C. wallichiana* DC. as conspecific with *C. mimosoides* L. and *C. leschenaultiana* DC. as a subspecies of latter, and *C. auricoma* (Grah. ex Benth.) Stey. as a variety under *C. mimosoides* L. subsp. *leschenaultiana* (DC.) Ohashi. The study of Indian material of the *C. mimosoides* group reveals that the treatment given by Ali & Quraishi (1967) is more satisfactory and should be followed.

The most suitable key to classify the variable elements of *C. mimosoides* group is as follows:

1. Stamens 5 or 4 .... *C. hochstetteri*
1. Stamens 7 to 10:
   2. Rachis serrate. Leaves 8-10 cm long; leaflets 40-60 pairs. Pods 2.5-5 cm long, 18 to 25 - seeded .... *C. mimosoides*
   2. Rachis entire, not serrate. Leaves 2.5-5 cm long; leaflets 16-24 pairs. Pods 1-2 cm long, 8 to 16-seeded:
      3. Fertile stamens 10. Plants hairy:
         4. Hairs on the stem and branches appressed, not spreading .... *C. wallichiana* var. *wallichiana*
         4. Hairs on the stem and branches spreading, not appressed .... *C. wallichiana* var. *auricoma*
      3. Fertile stamens 7, 9 or very rarely 10. Plants glabrous or glaucous .... *C. leschenaultiana*

The synonymy and distribution of these taxa are as follows:

A. C. HOCHSTETTERI Ghesq. in Bull. Jard. Bot. Brux. 9: 155. 1932.

C. nictitans Hochst. ex Oliv. Fl. Trop. Afr. 2: 28. 1871 (non Linn. 1753).

C. dimidiata Roxb. Hort. Beng. 32. 1814 (nac Ham. ex D. Don, 1825).

Senna dimidiata Ham. ex Roxb. Fl. Ind. 2: 352. 1832 (non *C. dimidiata* Ham. ex D. Don, 1825).

C. mimosoides Linn. var. *dimidiata* (Ham. ex Roxb.) Baker in Hook. f. Fl. Brit. Ind. 2: 266. 1878.

C. sparsa Stey. in Bull. Jard. Bot. Brux. 21: 359. 1951 pro parte.

Distribution: Pakistan, India, Ethiopia, China and Japan.

B. C. MIMOSOIDES Linn. Sp. Pl. 1: 379. 1753.

C. sensitiva Roxb. Hort. Beng. 32. 1814 nom. nud.

C. tenella Roxb. Hort. Beng. 32. 1814 nom. nud.

C. roxburghiana Grah. in Wall. Cat. 5323. 1831-32.
C. amoena Ham. in Wall. Cat. 5321. 1931-32.
Senna sensitiva Roxb. Fl. Ind. 2: 353. 1832.
S. tenella Roxb. Fl. Ind. 2: 354. 1832.

Distribution: India, Sri Lanka and Malaysian peninsula.

C. C. WALLICHIANA DC. Mem. Soc. Phys. Hist. Nat. Geneve 2(2): 133. 1824. var. WALLICHIANA.
C. dimidiata Ham. ex D. Don, Prodr. Fl. Nep. 247. 1825.
C. mimosoides Linn. var. *wallichiana* (DC.) sensu Baker in Hook. f. Fl. Brit. Ind. 2: 266. 1878 (in part, i.e. excl. *C. leschenaultiana* DC.).

Distribution: Pakistan, India, Bhutan and Nepal.

D. C. WALLICHIANA DC. var. AURICOMA (Grah. ex Benth.) Ali in Sind Univ. Sci. Res. Journ. 3: 10. 1967.
C. mimosoides Linn. var. *auricoma* Grah. ex Benth. in Trans. Linn. Soc. 27: 580. 1871.
C. auricoma (Grah. ex Benth.) Stey. in Bull. Jard. Bot. Brux. 20: 246. 1950.
C. leschenaultiana DC. var. *auricoma* (Grah. ex Benth.) de Wit in Webbia 11: 282. 1955.

Distribution: Pakistan, India Sri Lanka & Nepal.

E. C. LESCHENAULTIANA DC. Mem. Soc. Phys. Hist. Nat. Geneve 2: 132. 1824.
C. mimosoides Linn. var. *wallichiana* (DC.) sensu Baker in Hook. f. Fl. Brit. Ind. 2: 266. 1878 (in part, i.e. excl. *C. wallichiana* DC.).

Distribution: India, Sri Lanka and Malaysian peninsula.

5. **Cassia surattensis** Burm. f. Fl. Ind. 97. 1768.

AND

C. suffruticosa Keon. ex Roth, Nov. Pl. Sp. 213. 1821.

It would have been unnecessary to discuss the nomenclatural problem of *C. glauca* Lamk. and *C. surattensis* Burm. f., as there is unanimity of opinion regarding the validity of the published name *C. surattensis* Burm. f. for *C. glauca* Lamk. But. unfortunately, a distinct taxon named *C. suffruticosa* Koen. ex Roth has been wrongly interpreted as conspecific with *C. surattensis* Burm. f. (Bentham, 1871; Ali & Quraishi, 1967 etc.) or as its variety (Baker 1878; Chatterjee 1960 etc.). Britton (1930) placed this plant under his newly created genus *Psilorhegma* and named it *P. suffruticosa* (Koen. ex Roth) Britton. Fischer (Kew Bull. 1932: 56) examined Koening's specimens from India, now kept at Lund Herbarium, but did not find any specimen of *C. suffruticosa, C. glauca* or *C. surattensis*. A close examination of all available Indian material of *C. suffruticosa* Koen. ex Roth and *C. surattensis* Burm. f. reveals that these two taxa are quite distinct and clearly distinguishable on the basis of the following characters, which have not been given due consideration so far, and they should be considered as two distinct species rather than reducing *C. suffruticosa* Koen. ex Roth to the variety of *C. surattensis* Burm. f.

Leaflets 4-6 pairs, lanceolate or ovate-lanceolate, 4.5-7 × 2-3 cm; stipules ensiform, persistent. Petals subequal, 2-3 cm long. Bracts broadly ovate, acuminate, reflexed. Tip of anthers straight, not reflexed backwards. Pods 10-15 × 1-2 cm, 15 to 30-seeded. Seeds narrowly oblong, 6-7 × 2.5-3 mm; cotyledons slightly wrinkled; areole reticulately veined without transverse septa (Fi. B_1-B_5) .... *C. surattensis*

Leaflets 8-9 pairs, oblong or obovate-oblong, 2-4 × 1.3-2 cm; stipules linear-lanceolate, deciduous. Petals distinctly unequal, 1.5-2 cm long. Bracts narrowly ovate-lanceolate, not reflexed. Tip of anthers reflexed backwards. Pods 5-9 × 1-1.5 cm, 6 to 12-seeded. Seeds obovate, 4-5.5 × 1.5-2 mm; cotyledons not wrinked; areole longitudinally straited, with transverse septa (Fig. B_6 - B_{10}) .... *C. suffruticosa*

The synonymy and distribution of these taxa are as follows:

A. C. SURATTENSIS Burm. f. Fl. Ind. 97. 1768.
C. glauca Lamk. Encycl. 1: 647. 1785.
C. arborescens Vahl, Symb. Bot. 3: 56. 1794 (non Mill. 1768).

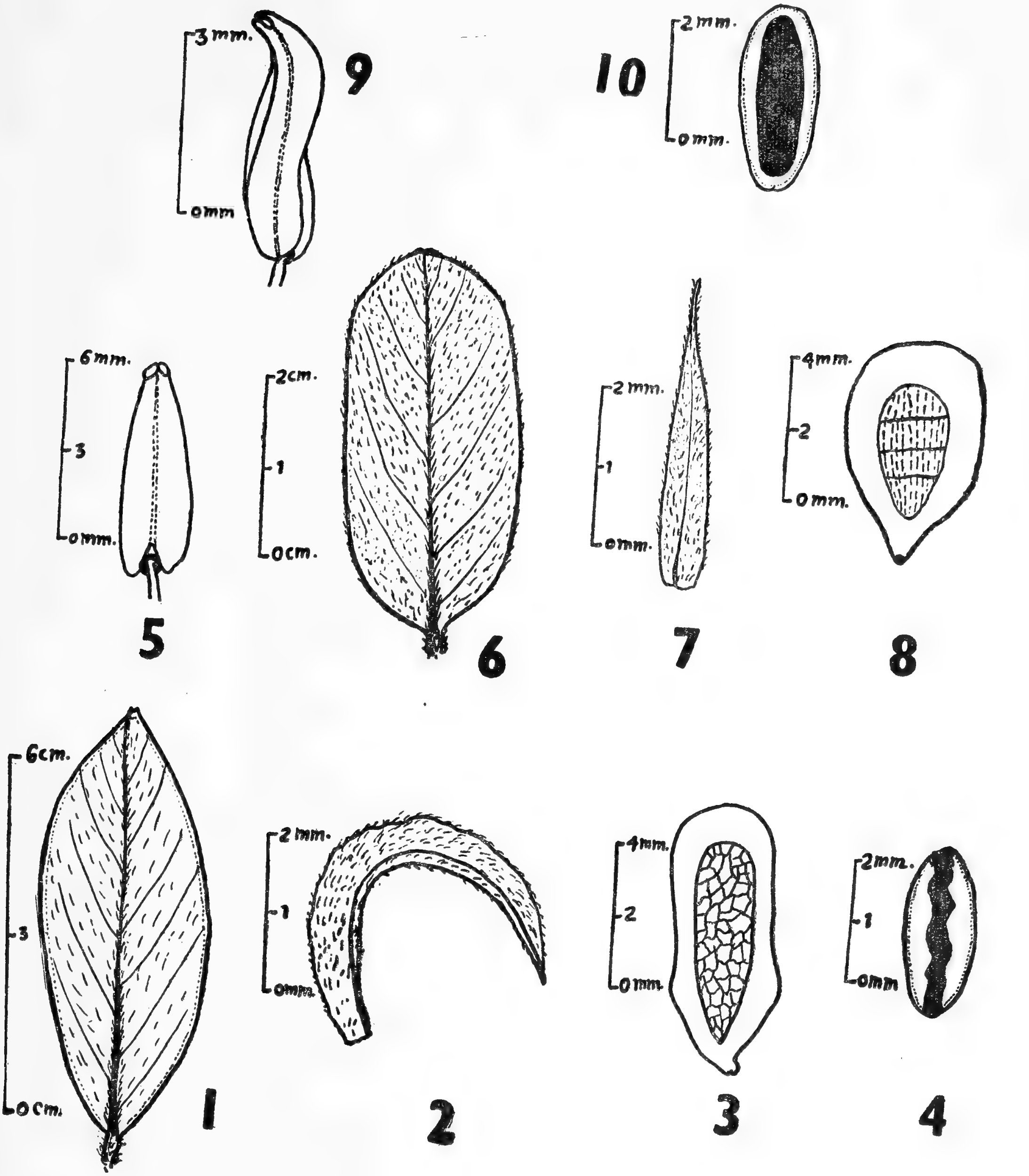

Fig. 3. *Cassia surattensis* Burm. f. — 1. Leaf (dorsal view), 2. Stipule, 3. Seed, 4. T.S. of Seed, 5. Anther; *C. suffruticosa* Koen. ex Roth — 6. Leaf (dorsal view), 1. Stipule, 8. Seed, 9. Anther, 10. T.S. of Seed.

C. discolor Desv. Journ. Bot. 3: 73. 1814.
C. sulphurea DC. Prodr. 2: 495. 1825.
Senna arborescens Roxb. Fl. Ind. 2: 345. 1832.

Distribution: Indigenous in S.E. Asia, Malay peninsula, Sumatra, Java, India, Burma, Sri Lanka, S. China, Formosa, Australia. Cultivated in many countries.

B. C. SUFFRUTICOSA Koen. ex Roth, Nov. Pl. Sp. 213. 1821; in DC. Prodr. 2: 496. 1825; W. & A. Prodr. 289. 1834; Benth. Pl. Austral. 2: 285. 1894.
Senna speciosa Roxb. Fl. Ind. 2: 347. 1832.
Cassia horsfieldii Miq. Fl. Ind. Bat. 1: 99. 1855.
Cassia acclinis F. Muell. Fragm. 4: 13. 1864.
C. glauca Lamk. var. *suffruticosa* (Koen. ex Roth) Baker in Hook. f. Fl. Brit. Ind. 2: 265. 1878.
Psilorhegma suffruticosa (Koen. ex Roth) Britton in North Am. Fl. 23: 255. 1930.
Cassia surattensis Burm. f. var. *suffruticosa* (Koen. ex Roth) Chatt. in Journ. Bomb. Nat. Hist. Soc. 57(3): 695-698. 1960.

Distribution: Malaya, Java, Burma, India, Australia and cultivated in many countries.

Further, *Cassia fastigiata* Vahl (Symb. Bot. 3: 57. 1794) excl. descr. 'glandulis inter omnia paria' probably belongs here as indicated by Wight & Arnott (Prodr. 290. 1834) and Prain (J. As. Soc. Beng. 66: 477. 1897). The varietal name *C. glauca* Lamk. var. *suffruticosa* (Koen. ex Roth) Baker has been wrongly ascribed to Prain in Gamble's FLORA OF MADRAS (403, 1919) instead of to Baker.

6. **Cassia pumila** Lamk. Encycl. Meth. 1: 651. 1785.

So far, typical *C. pumila* Lamk. is believed to possess upto 20 pairs of leaflets of maximum 13 × 2.5 mm size and a single stalked, peltate gland on the petiole below the lowest pair of leaflets. The specimen No. Shetty 1800, collected from Chang Chittar Forest Range (Pali), lodged in Central National Herbarium, Calcutta and Arid Zone Circle, Jodhpur and specimen No. Kanodia 1975, collected from Ramnagar (Pali) and lodged in the herbarium of Central Arid Zone Research Institute, Jodhpur, differ from proper *C. pumila* Lamk. in that they possess more than 20 pairs of leaflets (usually 28 pairs) of maximum 18 × 3.5 mm size and besides the solitary glands on the petioles, there are similar glands between each pair of leaflets in young leaves. The older leaves are without such glands between the pairs of leaflets. The stalks of rachis-glands are very weak and soon fall down, while those of petioles are stout and persistent. An examination of large material from different parts of the country reveals that there are many intermediate forms as regards the number and size of leaflets and the presence of glands between the leaflets is almost a universal feature of this taxon, but young leaves are to be examined because their stalks are very weak and soon fall down. Further, Deflers (1889) had recognised a variety *yemensis* Defl., endemic to Wasil, under *C. pumila* Lamk. (Blatter 1919-36). As the original material and description of variety *yemensis* Defl. are not yet available to me, it is not possible to comment upon it. But, in the light of present observation, an addition in the description of *C. pumila* Lamk. is necessary and it is presented below.

Plants erect, suberect or prostrate, upto 50 cm high or long. Leaves upto 8 cm long; leaflets upto 28 pairs, upto 18 × 3.5 mm. Solitary gland on the petiole and on the rachis between each pair of leaflets; former persistent; latter deciduous. Anthers unequal. Pods upto 4.5 cm long, straight or slightly falcate (Fig. A_7).

The synonymy and distribution of the taxon is as follows:

CASSIA PUMILA Lamk. Encycl. Meth. 1: 651. 1785.
C. prostrata Roxb. Hort. Beng. 32. 1814 nom. nud. (non Humb. & Boupl. ex Willd. 1809).
Senna prostrata Roxb. Fl. Ind. 2: 352. 1832.

Distribution: Africa, Arabia, Afghanistan, Pakistan, India, Malaya and Australia.

Acknowledgements

I thank the Director, National Botanic Gardens, Lucknow and Director, Botanical Survey of India, Calcutta, for the facilities and the C.S.I.R., New Delhi for providing financial assistance during the year 1968-1971. I am also thankful to the authorities of various Indian herbaria for herbarium and library facilities and to the Regional Botanist, Arid Zone Circle, Jodhpur for taking keen interest during the course of present study.

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FIELD IDENTIFICATION OF SOME INDIAN VULTURES (*GYPS BENGALENSIS, G. INDICUS, G. FULVUS,* AND *TORGOS CALVUS*)[1]

ROBERT B. GRUBH[2]

(*With three plates*)

Five species of vultures were regularly observed in the Gir Forest, western India, during the study period of two years from 1970 to 1972. These were, three species of griffons (whitebacked *Gyps bengalensis,* longbilled *G. indicus* and fulvous griffon *G. fulvus*), the king vulture *Torgos calvus* and the Egyptian vulture *Neophron percnopterus.* The continual observation of these vultures enabled me to distinguish them in various plumage stages. Based on this knowledge the following field identification keys and tables were prepared particularly for the griffons (*Gyps* spp.) and the king vulture. In addition to observing birds in the field thirty specimens were studied in captivity and eleven as freshly killed specimens. Immature birds were studied at nests and at carcasses.

Field identification keys to recognise these vultures in flight form the first part of this paper. Plumage characteristics and colours of bare parts that can be observed on vultures that are perched, or sitting on the ground close at hand, have been presented in the second section as tables for easy comparison. Satisfactory and comprehensive keys to distinguish Indian vultures in the field have not been worked out by earlier workers.

The Egyptian vulture can be easily separated from other vultures by its eagle-like flight, much smaller size, and wedge-shaped tail (Plate I), and hence it is not described here. The king vulture too has been excluded from the tables as it is never confused with the griffons when at rest.

Part 1. KEYS TO IDENTIFY VULTURES IN FLIGHT

The keys are of three categories. The first key is for identifying vultures flying high over head when the colours of their plumage are indistinguishable, except the sharply contrasting shades. The second and the third keys are to identify species when they fly close enough to enable the observer to distinguish the different markings and hues of the plumage. Whereas the second key is to identify vultures flying low overhead, enabling a closer view of their ventral aspect, the third key is to recognize the species by viewing their dorsal aspect which is possible when viewed from above or when the bird banks while circling low overhead. The third key is especially useful for observers on hills when vultures glide past below eye level.

Key 1: *Ventral view in flight; only sharply contrasting hues visible* (Plate I)

I. Underwing coverts white, rest blackish .... *G. bengalensis* (adult)

[1] The paper is based on a portion of the Ph.D. thesis 'The Ecology and Behaviour of Vultures in Gir Forest' submitted by the author to the University of Bombay in 1974.

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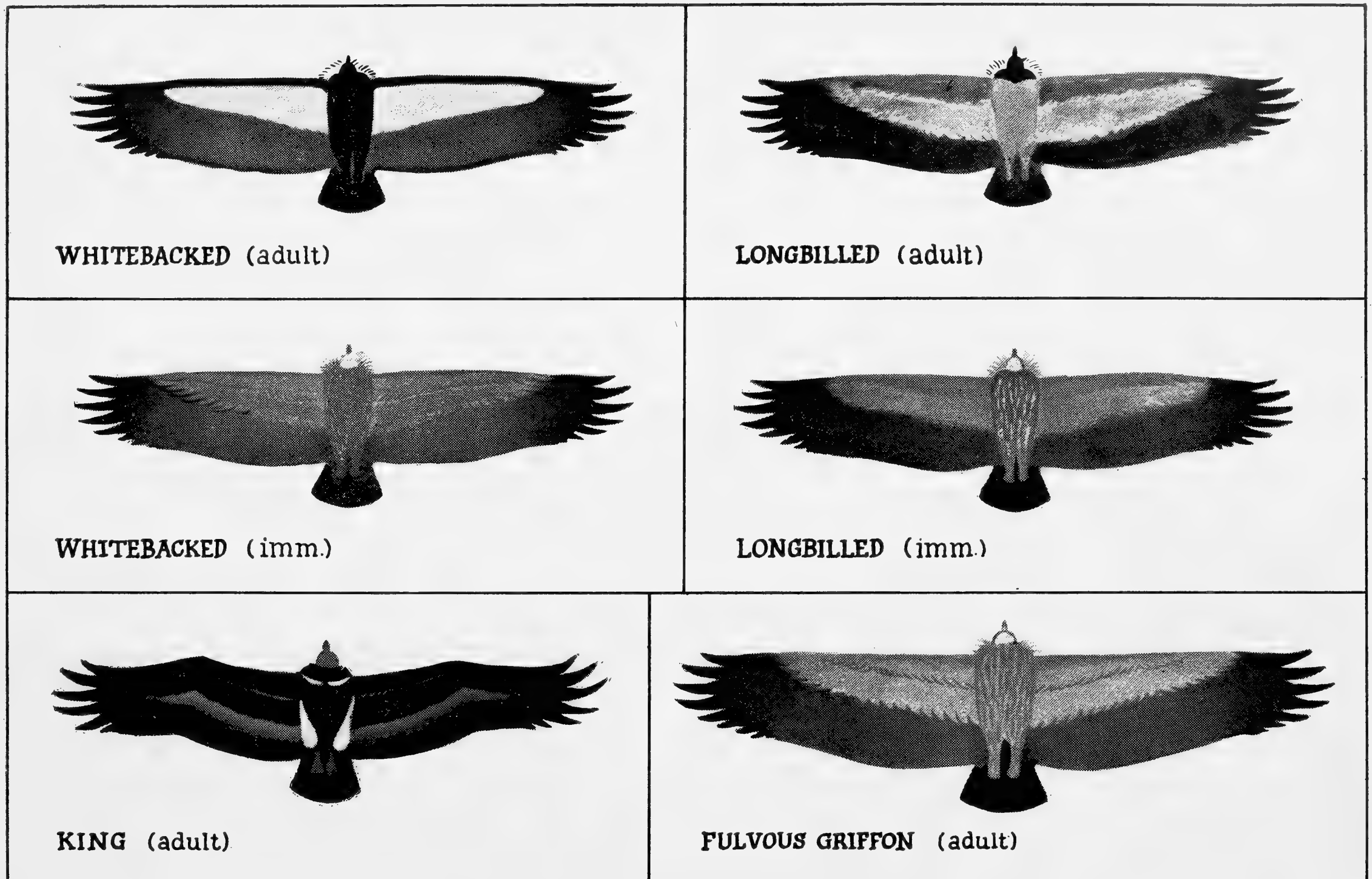
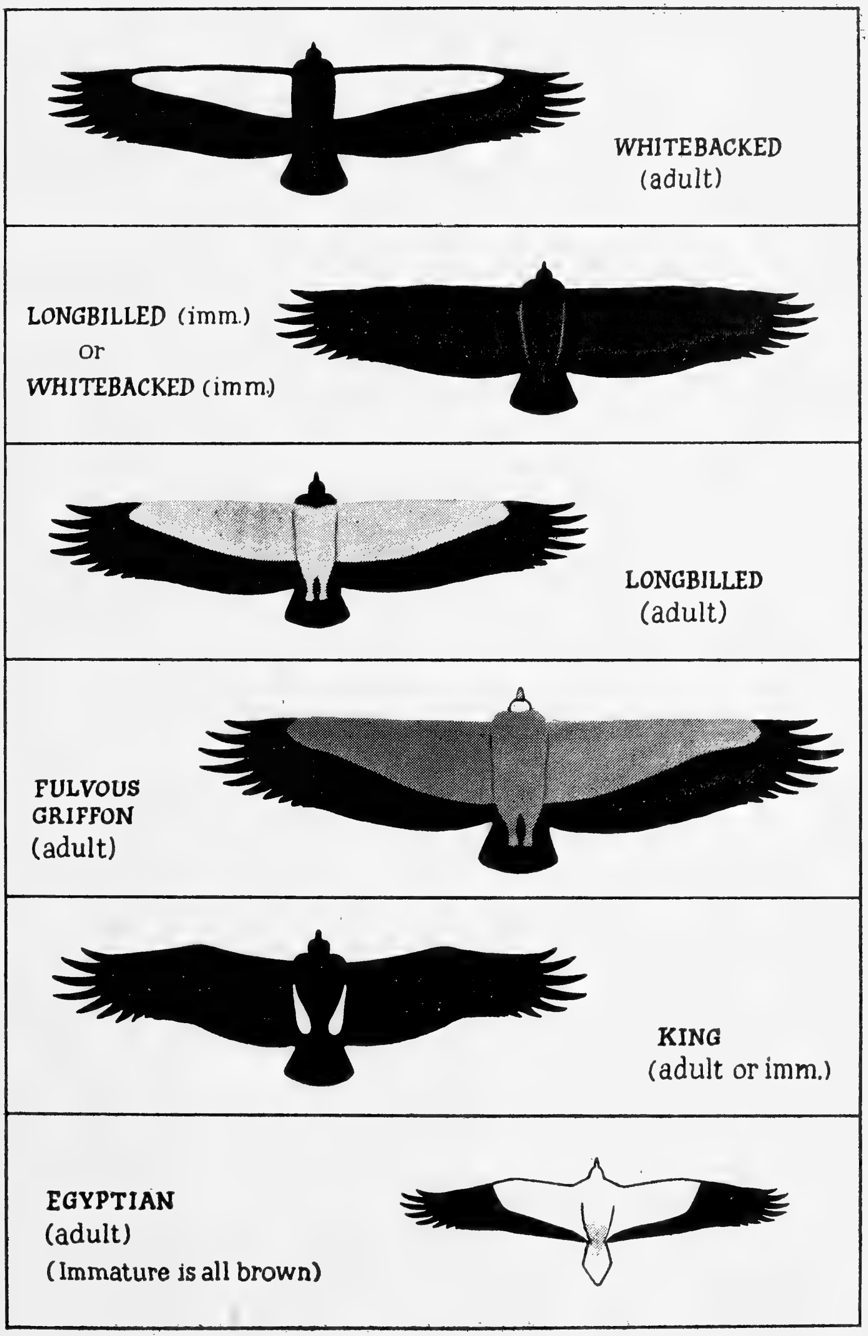
PLATE II



Low ventral view of vultures in flight. Colours visible.



Silhouetted shapes and contrasting hues of high-flying vultures (Ventral View).

II. Broad white oval marking on either side of the body, rest blackish .... *T. calvus* (adult & immature)

III. Light body plumage; black head and neck; rectrices and remiges merge with the blue sky but stand out in white cloud background ... *G. indicus* (adult)

IV. Darker, more or less uniform hue.... *G. bengalensis* (immature)
G. indicus (immature)
G. fulvus (immature & adult)

When flying high overhead, only the king vulture and adult longbilled and adult white-backed vultures can be identified with certainty. It is difficult to tell apart the fulvous griffon and immature individuals of white-backed and longbilled. But when fulvous griffon is seen in flight alongside other species it can be easily separated by its larger size.

Key 2: *Ventral view in flight*: *colours visible* (Plate II)

I. Underwing coverts bright white and rest of the plumage blackish .... *G. bengalensis* (adult)

II. Broad oval white marking on either flank and rest of the plumage dark... *T. calvus* (adult & immature)
  (a) Pale pink head and legs, and dark brownish to black general plumage... *T. calvus* (immature)
  (b) Bright red head and legs; black general plumage ... *T. calvus* (adult)

III. Isabelline (yellowish grey) plumage contrasting with blackish quill feathers ... *G. indicus* (adult & immature)
  (a) Head, neck and crop black ... adult
  (b) Head, neck and crop paler ... immature

IV. Light to dark brown uniform plumage
  (a) Size large ... *G. fulvus* (immature)
  (b) Size small ... *G. bengalensis* (immature)

V. Bright cinnamon brown plumage; quill feathers blackish; large bird... *G. fulvus* (adult)

Key 3: *Dorsal view in flight*: *colours visible* (Plate III)

I. Whitish lower back (by contrast) .... *G. bengalensis* (adult)
T. calvus (adult & immature)
T. calvus (adult & immature)
  (a) General plumage isabelline buff, contrasting with black rectrices and remiges ... *G. indicus* (adult & immature)
    (i) Black head and neck ... adult
    (ii) Whitish head and neck ... immature
  (b) General plumage blackish
    (i) Head and neck bare, dark brown ... *G. bengalensis* (adult)
    (ii) Head bare and red or pale pink; neck feathered ... *T. calvus* (adult & immature)

II. Lower back, of the same colour as the rest of the dorsal plumage.
  (a) Bright cinnamon brown body and dark quill feathers ... *G. fulvus* (adult)
  (b) Light brown body and darker quill feathers
    (i) Size large ... *G. fulvus* (immature)
    (ii) Size small ... *G. bengalensis* (immature)

In keys 2 and 3, immature individuals of fulvous griffon and whitebacked have been

separated only by size and it might appear ambiguous. However, when seen at low heights, the size difference is sufficiently conspicuous even when both species are not seen side by side. The approximate wing span of white-backed is 2 m while that of the fulvous griffon is about 2.4 m (Brown & Amadon 1968).

Part 2: Plumage stages and colour of bare parts

Only the whitebacked and the longbilled vultures were studied in detail. The descriptions given in the tables (Tables 1 & 2) are limited to characters which are rather conspicuous in the field when the birds are at rest and are reasonably close.

Three different plumages were observed in the whitebacked and longbilled vultures. Birds possessing similar plumage to that of fledglings at nest were considered to be of the first category and their plumage referred to as initial plumage. Although not definitely known it is generally believed that this initial plumage lasts for one year (studied in the African Whitebacked *Gyps africanus* by Houston–pers. com.), and hence birds in this plumage are considered to be first year birds. In this plumage both the longbilled and the white-backed have contour feathers with pointed tips which is readily noticeable from a distance.

The initial plumage is later on replaced by an intermediate plumage in whitebacked vultures. The feathers are brown and have rounded tips. The third and final plumage too has feathers with rounded tips, but are brownish black all over except on the back and under-wing coverts which are pure white and the partially greyish inner remiges. That the 'intermediate' plumage precedes the black-and-white plumage was confirmed by the fact that some of the intermediate individuals still retained a few 'first year' feathers while some others had a few fresh black feathers. Also majority of the breeding birds possess the black-and-white plumage.

The Indian whitebacked was not known to have three types of plumages although in the African whitebacked vulture (*Gyps africanus*) it has been noticed (Houston, pers. com.).

Sexual dimorphism is not known in any of the griffons (*Gyps* spp.) although Lowe (1929) has indicated possible sexual dimorphism in the African whitebacked vulture.

In the longbilled vulture there appear to be more than one transitional plumage stage before attaining the final plumage which is almost uniformly isabelline (yellowish grey) contrasting with the blackish wing and tail feathers, and black head and neck. These intermediate stages appear very similar to each other, differing only in the extent of darkness in the plumage. Perhaps it is merely individual variation and not definite plumage types at all. Therefore the post juvenile-and-preadult stage has been taken here as a single intermediate plumage.

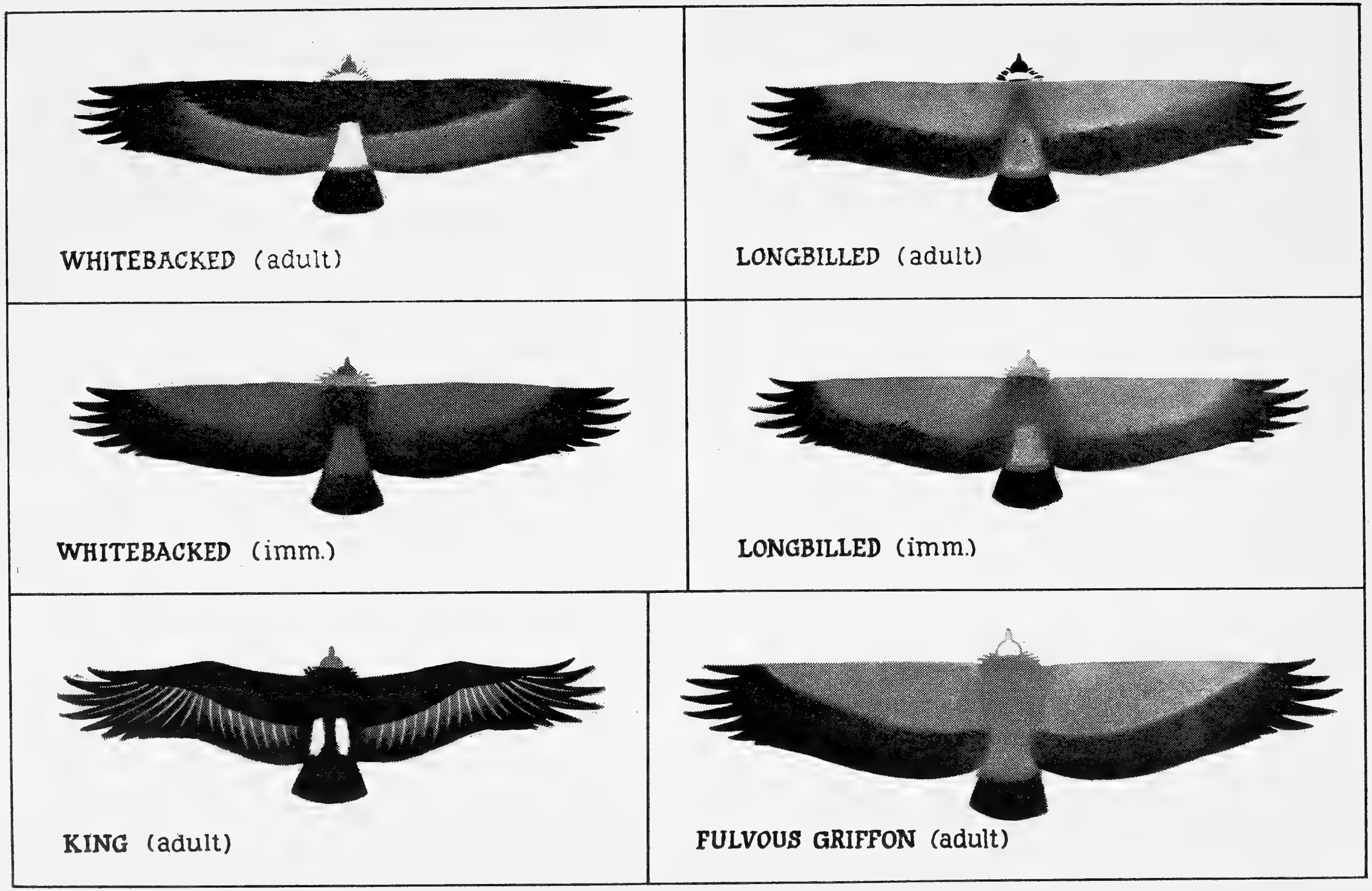
So far the longbilled and whitebacked were thought to be inseparable in the field in the initial plumage (Sálim Ali & Ripley 1968). But as indicated under keys, and tables 1 and 2, there are definite differences in their plumage which are unmistakable even in the field.

Whitebacked and fulvous griffons in non-adult plumage stages resemble each other to a large extent. But the fulvous griffon is a much larger bird (weight: *c* 7.1 kg n. 1) than the whitebacked (weight: *c* 4.4 kg n. 29) and hence it is easy to distinguish them by their size difference.

Gyps fulvus

Since the fulvous griffons did not visit the Gir in large number, and the birds in non-adult plumages formed only a small portion, it was not possible to make a satisfactory

PLATE III



Close dorsal view of vultures in flight. Colours visible.

TABLE 1

INDIAN WHITEBACKED VULTURE *Gyps bengalensis*

Body parts	Initial plumage	Intermediate plumage	Final plumage
General appearance	Dark brown to light brown	Light brown	Brownish black
Lower back and rump	Dark brown, narrowly streaked fulvous on the rump	Light brown, plain	Pure white
Rest of dorsal plumage	Dark brown, streaked fulvous; feather tips pointed	Light brown, feather tips rounded	Brownish black; feather tips rounded
Underwing coverts	Dark brown, streaked fulvous	Dark brown, streaked creamish	Pure white
Rest ventral plumage	Dark brown, boldly streaked fulvous lanceolated feathers; tips pointed	Brown, boldly streaked creamish; feather tips rounded	Blackish brown, feather tips rounded, secondaries and inner primaries greyish
Ruff	Dull brown, broadly streaked fulvous, lanceolated, long	Fulvous with faint dark edges lanceolated, short	Creamish white, and without barbules, thus appearing fluffy
Head and Neck	Dark to dull brown down dorsally; rest bare and the skin greenish white	Pale brown to creamish white down dorsally; rest bare and the skin bluish white to brownish white	Creamish white bristles dorsally from forehead to upper neck; rest bare and the skin dark brown
Crop	Very short, smooth fur-like dark brown feathers	Very short, smooth, fur-like light brown feathers	Very short, smooth, fur-like blackish brown feathers
Clavicular skin	Creamish	Creamish	Creamish
Cere	Blackish brown	Blackish brown	Blackish brown
Upper mandible	Blackish brown	Blackish brown with narrow pale grey marking on basal half of culmen	Dark grey with broad pale grey centre on either side and basal half of culmen
Lower mandible	Blackish brown	Blackish brown	Blackish brown
Tarsus and Toes	Dark grey	Dark grey	Dark grey
Claws	Dark grey	Dark grey	Dark grey

TABLE 2

LONGBILLED VULTURE *Gyps indicus*

Body parts	Initial plumage	Intermediate plumage	Final plumage
General appearance	Dull isabelline	Dull isabelline	Bright isabelline
Lower back and rump	Pale brownish grey feathers with broad isabelline streaks	Isabelline, becoming darker anteriorly	Isabelline, becoming darker anteriorly
Upper back	Dark brown, almost plain, feather tips pointed	Greyish brown, rounded feather tips	Greyish brown, rounded feather tips
Rest of dorsal plumage	Greyish brown feathers with broad bright isabelline centres, tips pointed	Dull isabelline feathers, basally brownish grey, tips rounded	Bright isabelline feathers, greyish basally and tips rounded
Underwing coverts	Greyish brown with fulvous streaks	Greyish brown with fulvous streaks	Pale brownish grey
Rest of ventral plumage	Pale brown, broadly streaked isabelline; lanceolated feathers with pointed tips	Dull isabelline, lanceolated feathers with rounded tips	Bright isabelline broader feathers with rounded tips
Rectrices and remiges	Blackish brown, tips pointed	Blackish brown, tips rounded	Blackish brown, tips rounded
Ruff	Dull brown, broadly streaked fulvous, lanceolated, long	Fulvous with faint dark edges, lanceolated, short	Creamish white and without barbules, thus appearing fluffy
Head and neck	Creamish white, tinged pale grey on head; scattered down	Dirty greyish skin with scattered down	Brownish black skin and almost bare
Calvicular skin	Creamish	Dark grey	Dark grey
Cere	Blackish grey	Pale grey	Pale grey
Upper mandible	Blackish grey but pale grey dorsally on the curve of the culmen	Pale grey except on sides which are brown	Pale grey
Lower mandible	Blackish grey except proximal and distal edges which are pale grey	Pale grey basally, rest brown	Pale grey
Tarsus and toes	Dark grey	Dark grey	Dark grey
Claws	Dark grey	Pale grey	Pale grey

study of the plumages. However, two distinct plumages were noticed. The adult plumage was bright cinnamon and the feathers were rounded at the ends. The head and neck were densely covered with creamish white down. The immature plumage was more of brown with pointed feathers and the head and neck sparsely covered with darker down. An intermediate plumage resembling that of the immature plumage also has been observed by others (Witherby *et al.* 1943).

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3

STUDIES ON THE GENUS *CYMBOPOGON* SPRENG. VIII:[1]
A contribution to the classification of Indian species of *Cymbopogon*

B. K. GUPTA[2]

An artificial key has been prepared for 23 Indian species of *Cymbopogon* Spreng., which have been placed under 3 series. The original rank of *Cymbopogon confertiflorus* (Steud.) Stapf has been restored.

During the course of a cytosystematic study of the Indian *Cymbopogon,* I had the opportunity of studying natural populations of various species of this genus in different parts of India besides the herbarium specimens at the principal Herbaria of India. (BLAT, CAL, MH, LWG, BSD, DD and Fyson collections maintained in the Herbarium of the Presidency College, Madras). Many of these were also grown in the Sir Ram Nath Chopra garden of medicinal plants at Regional Research Laboratory, Jammu and detailed observations made on their growth habits and floral characters. In all, 23 species were studied which included three new species and seven new varieties described by me (Gupta 1970a,b,c, d). Bor (1963) reported that *C. schoenanthus* (Linn.) Spreng. does not occur in India and assigned all the Indian specimens included under this species to *C. olivieri* (Boiss.) Bor. Similarly *Cymbopogon tibeticus* Bor has been transferred to *Andropogon tristis* Nees ex Hack. (Bor 1973). All these facts have necessitated provision of an artificial key to the Indian *Cymbopogon* including the newly described taxa.

The classification of the Indian species of *Cymbopogon* has been attempted in the past by Hackel (1889), Hooker (1896), Stapf (1906), Camus (1921) and Bor (1953). Bor reduced *C. confertiflorus* (Steud.) Stapf to varietal rank under *C. nardus* (Linn.) Rendle which is considered as the mother plant of the latter (Bor 1953, p. 895). However, no uniform criteria have been followed in placing different races or forms under a specific or varietal rank. For instance *C. confertiflorus* (Steud.) Stapf has been reduced to varietal rank because the oil obtained from this species is similar to *C. nardus* (Linn.) Rendle (Bor 1953, p. 895). On the other hand, the erection of two species *C. nardus* (Linn.) Rendle and *C. winterianus* Jowitt from *C. nardus* Rendle on slight morphological differences has been supported, although the oil obtained from both is similar (Bor 1953, p. 907). Secondly, a support for a specific rank to *C. caesius* (Nees) Stapf and *C. martinii* (Roxb.) Wats. var. *sofia* Gupta, on morphological grounds has been expressed, although the oil obtained from *C. martinii* var. *sofia* and *C. caesius* is similar (Bor 1953, p. 896). Thirdly, *C. jwarancusa* (Jones) Schult. and *C. olivieri* (Boiss.) Bor have been treated at the specific rank though they yield a similar oil (Gupta 1969c).

There are now two possibilities, either to treat *C. confertiflorus* as a variety of *C. nardus* or to consider it as a separate species irrespective of the nature of oil obtained from

[1] Accepted January 1977.

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it. In my opinion, the restoration of an original rank of species to this plant is most desirable for the following reasons.

1. Bor transferred *C. confertiflorus* under *C. nardus* as a variety in the light of Mr. Jowitt's findings on these grasses (Bor 1953, p. 890).

2. Jowitt's opinion about the nomenclature of 'nardus complex' is recorded here in his own words which runs thus "It may be that it is possible to recognize two species of *mana*, an awned and awnless one, but neither of them includes Mahapangiri" (Jowitt 1908, p. 187).

3. In India—*C. nardus* is found under cultivation only and usually not allowed to flower.

4. The Indian specimens placed under *C. nardus* var. *confertiflorus* are quite different from the Sri Lanka ones, i.e. the upper lemma of sessile spikelet is always bilobed up to the middle and awned in the sinus. The difference has been found to be constant with Indian specimens. Haines (1921) even went a step further in not recognizing the awnless plant as a valid species since no definite locality is known for its occurrence in India, and has described another awned species under the name *C. nardus* Linn. which is probably a plant belonging to *C. confertiflorus.*

5. The concentration of *Cymbopogon confertiflorus* is more in south India than in Sri Lanka (Bor 1953, p. 905). It is also probable that Jowitt sheets of 'Nardus complex' might be representing a case of introgressive hybridization—as all the ten specimens examined by him did not show constancy in their awn and upper lemma characters and represented a mixture of these two species and their distribution is also overlapping in Sri Lanka. Both interspecific and intraspecific hybridization are also prevalent in this genus (Bor 1953, Gupta 1971).

6. Both the species under consideration have been grown side by side by me and they do give a different facies.

7. If the classification is considered on the basis of the constituents of the oil, then *C. caesius* demands a varietal rank under *C. martinii; C. nardus* and *C. winterianus* Jowitt should be merged together under a single species; a similar consideration also applies to *C. citratus* Stapf and *C. pendulus* (Nees ex Steud.) Wats. where the main constituent of the oil is the same, citral.

Considering all these facts and for the sake of simplicity and to avoid further change in nomenclature, it is desirable to treat all these species reported by Bor (1953, 1963, 1973) as distinct and valid and also raising *C. confertiflorus* to its original rank.

In providing a key to the species reported here, it has been found convenient to place them under the following three series of Stapf (1906):—

A. Basal leaves linear, more or less filiform and rarely exceeding 0.6 cm in their breadth at the middle of the leaf; panicles more often narrow, of short, dense fascicles of raceme pairs or of 1-2 raceme pairs—series *Schoenanthi.*

B. Basal leaves more or less lanceolate, always more than 1 cm in breadth at the middle of the leaf with well developed midrib on the ventral side; panicles more often large and compound—series *Citrati.*

C. Basal as well as other leaves cordate, subcordate or rounded at the base; old culms naked at the base or with the withered remains of the basal leaf sheaths; lower glume of sessile spikelets with a slit like groove in the lower half which appears as a rib on the inner surface—series *Rusae.*

KEY TO THE SPECIES

A. 1. Grasses aromatic
2. Joints and pedicels profusely hairy, hairs more or less concealing the sessile spikelets;
3. Pedicel of the lowest spikelet of sessile raceme swollen.
4. Lower glume of sessile spikelet lanceolate, acute, not oblique at apex and with broader groove on the back .... *C. parkeri*
5. Keel nerves of lower glume of sessile spikelets scabrid .... *C. parkeri* var. *parkeri*
5. Keel nerves of lower glume of sessile spikelet winged .... *C. parkeri* var. *jammuensis*
4. Lower glume of sessile spikelet elliptic-acute, slightly oblique at apex and without any groove on the back ...... *C. ramnagarensis*
3. Pedicel of the lowest spikelet of sessile raceme not swollen.
6. Basal leaves filiform,
7. Sessile spikelets always less than 5 cm long, lower glume elliptic-acute ...... *C. olivieri*
7. Sessile spikelets always over 5 mm long, lower glume oblong-acuminate .... *C. ladakhensis*
6. Basal leaves linear, flat or V-shaped in transverse section .... *C. jwarancusa*
8. Lowest pair of spikelets of sessile raceme more or less homomorphous and homogamous .... *C. jwarancusa* var. *jwarancusa*
8. Lowest pair of spikelets of sessile raceme heteromorphous and heterogamous .... *C. jwarancusa* var. *assamensis*
2. Joints and pedicels hairy but not concealing the sessile spikelets:
9. Sessile spikelets less than 4.75 mm long, lower glume with a deep groove in the lower half .... *C. stracheyi*
9. Sessile spikelets over 5.5 mm long
10. Lower glume of sessile spikelet with a concave groove from base to apex, puberulent at the bottom, not oblique ...... *C. hookeri*
10. Lower glume of sessile spikelet with a shallow, continuous or interrupted groove from base to apex, usually oblique .. *C. distans*
11. 1 to 2 branches (rarely 3) arising from each node of the axis and ending in a pair of racemes, intercarinal nerves more than 2 on the back of the lower glume of sessile spikelet .... *C. distans* var. *distans*
11. More than 2 branches arising from each node of the axis and ending into a pair of racemes, intercarinal nerves 2 or absent on the back of the lower glume of sessile spikelet .... *C. distans* var. *mundensis*
1. Grasses almost non aromatic.
12. Spikelets less than 3.5 mm long, lower glume of sessile spikelets without prominent boss in the lower half .... *C. microtheca*
12. Spikelets over 4 mm long, lower glume of sessile spikelet with a prominent boss in the lower half .... *C. gidarba*
B. 13. Basal leaf sheaths persistent when old and not bright reddish inside:
14. Pedicel of the lowest pedicelled spikelet in the sessile raceme swollen:
15. Basal leaf sheaths do not curl spirally when old, panicle narrow, interrupted and congested .... *C. coloratus*
15. Basal leaf sheaths curls spirally when old, panicles effuse, spreading and drooping .... *C. travancorensis*
14. Pedicel of the lowest pedicelled spikelet in the sessile raceme not swollen:
16. Sessile spikelets always less than 5 mm long .... *C. flexuosus*
17. Panicles large and dense .... *C. flexuosus* var. *flexuosus*
17. Panicles large, lax, spreading or drooping:
18. Panicles long, slender, erect, bearing very few distant solitary erect branches with one or two epinastically deflexed raceme pairs .... *C. flexuous* var. *microstachys*
18. Panicles very large, much branched and the drooping branches with numerous raceme pairs:
19. Keel nerves of the lower glume of sessile spikelet narrowly winged from the apex.... .... *C. flexuosus* var. *sikkimensis*
19. Keel nerves of lower glume of sessile spikelet broadly winged little below the apex .... *C. flexuosus* var. *coimbatorensis*
16. Sessile spikelets always more than 5 mm long:
20. Lower glume of sessile spikelet concave, grooved from base to apex .... *C. pendulus*
20. Lower glume of sessile spikelet flat:
21. Sessile spikelets awnless .... *C. citratus*
21. Sessile spikelets awned ...... *C. khasianus*
22. Lower glume of sessile spikelet glabrous .... *C. khasianus* var. *khasianus*

22. Lower glume of sessile spikelet hairy .... *C. khasianus* var. *nagensis*
13. Basal leaf sheath persistent when old and always brick red inside*
23. Sessile spikelets awnless .... *C. nardus*
23. Sessile spikelets awned .... *C. confertiflorus*
C. 24. Pedicel of the lowest-pedicelled spikelet of sessile raceme not swollen:
25. Sessile spikelets awnless .... *C. osmostonii*
25. Sessile spikelets awned.
26. Inflorescence a simple panicle, one or two branches arising from each node of the axis and ending into a divaricate raceme pair at maturity .... *C. polyneuros*
26. Inflorescence a large, much branched compound panicle .... *C. motia*
24. Pedicel of the lowest pedicelled spikelet of sessile raceme grossly swollen:
27. Leaf blades linear, round at the base; inflorescence not bright red at maturity...... *C. caesius*
27. Leaf blades cordate or subcordate at base; Inflorescence bright red at maturity .... *C. martinii*
28. Lower glume of sessile spikelet elliptic-acute (excluding the wings) and broader at apex .... *C. martinii* var. *martinii*
28. Lower glume of sessile spikelet lanceolate acute (excluding the wings) and narrower at apex .... *C. martinii* var. *sofia*

* Based on Stapf's findings (1906, p. 320) besides author's own observations.

Acknowledgements

I am grateful to the Director, Botanical Survey of India, Calcutta, Prof. B. G. L. Swamy, Presidency College, Madras, Director N.B.G. Lucknow and President, Forest Research Institute, Dehra Dun for allowing me to work in their respective herbaria. I am equally thankful to the Director, Royal Botanic Gardens, Kew and in particular to the late Dr. N. L. Bor for the verification of some *Cymbopogon* species under investigation. I also owe sincere thanks to Dr. K. Subramanyam, Ex-Director, Botanical Survey of India for critically going through the manuscript and for helpful suggestions. Thanks are also due to University Grants Commission for financial help.

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NEW DESCRIPTIONS

STUDIES ON SOME SPIDERS OF THE GENERA *TEGENARIA* AND *AGELENA* FROM KHASI AND JAINTIA HILLS, INDIA (ARANEAE: AGELENIDAE)[1]

M. Barman[2]

(*With thirteen text-figures*)

Introduction

Our information about Indian Agelenids begins only with the recent contribution of Tikader (1962, 1968). Till the present work Indian Agelenid fauna was represented by a few species of *Agelena,* mostly from Khasi and Jaintia Hills area. In the present paper two more species (*Tegenaria shillongensis* and *Agelena oaklandensis*), new to arachnology are described and short report of the known species is also added.

I am grateful to Dr. B. K. Tikader, Deputy Director, Zoological Survey of India, Poona, for confirmation of the identifications.

The type specimens will be deposited in the National Collection of Zoological Survey of India, Calcutta in due course.

1. **Tegenaria shillongensis** sp. nov.

(Figs. 1-7)

General: Moderately large spider, carapace and chelicera dark brown, legs reddish brown, abdomen light grey with white chevron. Total length (♀) 10.20 mm. Carapace 4.50 mm. long, 4.00 mm. wide; abdomen 5.50 mm. long, 5.00 mm. wide.

Cephalothorax: Longer than wide, cephalic region narrow, convex and higher; thorax broad and almost flat. Both rows of eyes procurved, laterals of each side almost contiguous by a ridge. Laterals slightly larger than medians; all on small tubercles, ocular quad wider behind. Carapace dark brown, clothed with short hairs. Clypeal width more than the diameter of eyes. Chelicerae curved, inner margin of fang groove armed with six teeth. Labium 1.5 times longer than broad. Sternum shield shaped pointed behind, in front of coxae IV. Endite and chelicera with scopulae. Legs clothed with long hairs and few spines; tibiae and metatarsi with three pairs of ventral spines.

Abdomen: Oval, light grey with yellowish white chevrons on the dorsum. Ventral lighter with few faint patches. Both surfaces clothed densely with hairs. Spinnerets almost of same colour, anterior pair small, posterior pair long and with two segments. Epigynum paired with a median ridged as in text-fig. 4. Internal genitalia as in text-fig. 5. Male palpus as in text-figs. 6, 7.

Holotype: female, *paratype* 3 females, *allotype* male.

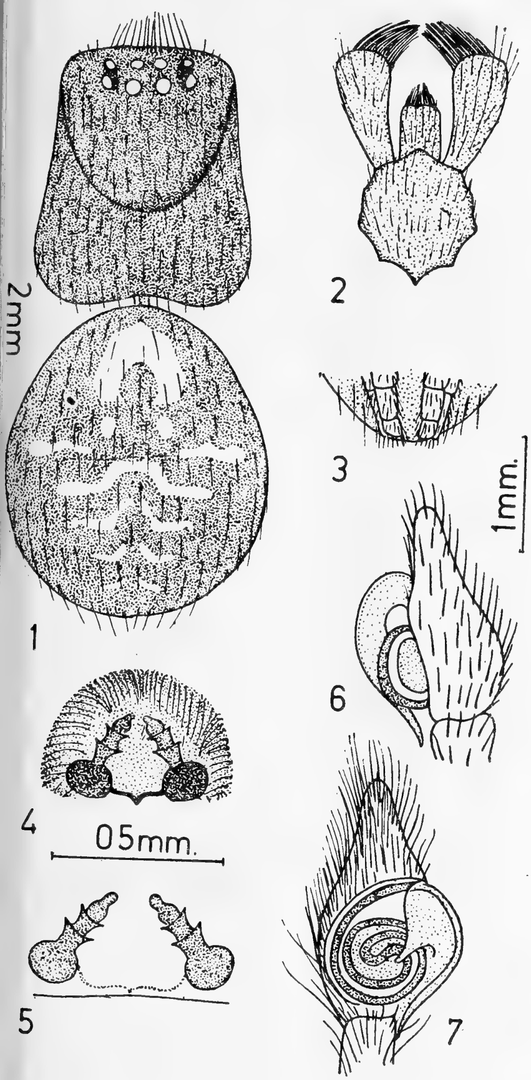
Type-locality : Kenches Trace (inside room), 25.8.1973, other females and male from same locality, 24.10.74. Coll. *M. Barman.*

Discussion: This species is closer to *Tegenaria lunakensis* Tikader but differs from it in (i) Body colour, (ii) Absence of foveal

[1] Accepted December 1977.

[2] Lady Keane College, Shillong, Meghalaya.

mark, (iii) Structure of epigynum and male palpus.



Figs. 1-7. *Tegenaria shillongensis* sp. nov. 1. Dorsal view of female, legs omitted; 2. Sternum with maxillae and labium; 3. Ventral view of posterior end of abdomen showing spinners; 4. Epigynum; 5. Internal genitalia; 6. Lateral view of male palpus; 7. Ventral view of male palpus.

These spiders live in funnel web built in the corners of houses or in near by bushes but are common in houses and become active in the night and are found to come out of the webs. They are found from April till November.

2. **Agelena gautami** Tikader

Agelena gautami Tikader, 1962, *J. Linn. Soc.*, London, 44(300): 569. Tikader, 1968, *J. Assam Sci. Soc.*, 11: 158.

Specimens examined: 3 females, Shillong, 21.6.1965 and 2 males, 16.7.1969. Coll. *M. Barman.*

Diagnosis: Body elliptical, covered with deep brown hairs, carapace light brown, lateral regions darker, longitudinal foveal line prominent; legs yellowish brown, clothed with long hairs and spines. Abdomen brown, anterior spinnerets separate, posterior spinnerets longer and provided with two segments. Total length (♀) 13.75 mm. Carapace 5.00 mm. long, 4.00 mm. wide; abdomen 9.00 mm. long, 4.10 mm. wide. Both rows of eyes procurved but the posterior row more strongly arached, posterior medians smaller, rest equal in size. Ocular quad almost a square anteriorly slightly narrower.

These spiders live in funnel like web with retreat, commonly they weave their webs in the corners of houses, bathrooms etc., wait for their prey in the opening of funnel and hide in the retreat when disturbed.

Distribution: So far this species is known only from its type locality, i.e. Shillong, Meghalaya, India.

3. **Agelena shillongensis** Tikader

Agelena shillongensis Tikader, 1968, *J. Assam Sci. Soc.*, 11 : 158.

Specimens examined : 4 females. Lawsohtun (Khasi Hills), 2 males, Shillong. Coll. *M. Barman*. 28.2.1969 and 10.7.1971 respectively.

Diagnosis : Carapace flat, oval, light brown, the middle of thoracic region with a fovea; laterally broad longitudinal deep brown patches and margins with a thin line, clothed with hairs and few spines. Eyes white, anterior row nearly straight, posterior row slightly procurved, medians nearer to each other than from adjacent lateral. Legs greenish brown, leg III shortest, trichobothrium prominent on leg IV. Abdomen oval, dark brown with light brown design, clothed thickly with greenish hairs. Total length (♀) 10.00 mm. Carapace 4.00 mm. long, 3.10 mm. wide; abdomen 5.20 mm. long, 3.10 mm. wide.

This spider is found in its sheet web with funnel like retreat in the bushes.

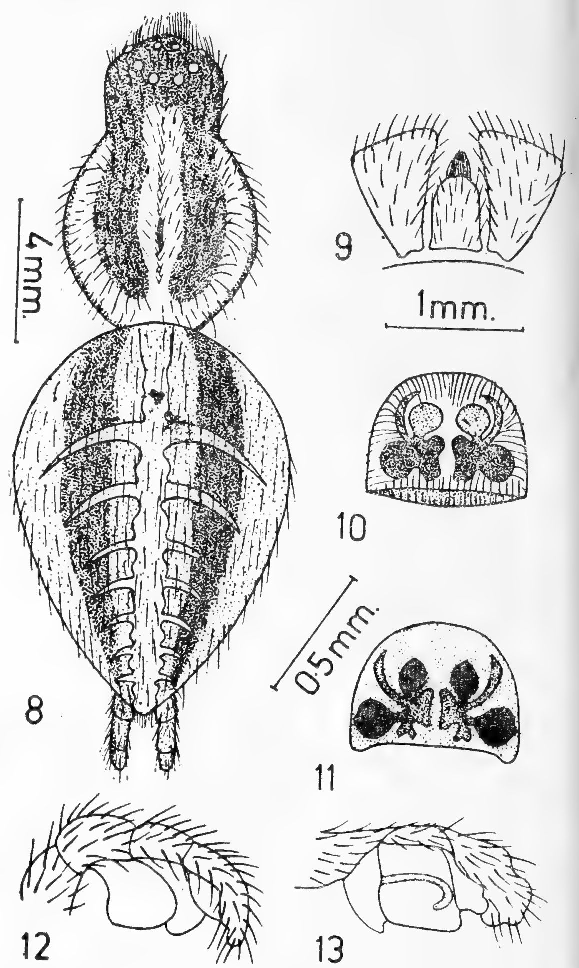
Distribution: Laban, Shilong, Lawsohtun (Khasi Hills), Meghalaya, India.

4. **Agelena oaklandensis** sp. nov.
(Figs. 8-13)

General : Large spiders, cephalothorax brown, legs yellowish with brown bands. Total length (♀) 19.00 mm. Carapace 8.00 mm. long, 5.50 mm. wide; abdomen 11.00 mm. long and 8.00 mm. wide.

Cephalothorax : Cephalic region narrower, higher and convex, thoracic region flat, fovea in the centre. Carapace dark brown in the cephalic region and from there a broad longitudinal patch extends on each side upto posterior end of carapace as in text-fig. 8; the area in between the patches and the outer lateral margins light brown. All eyes white, anterior medians larger, rest almost equal. Anterior row of eyes straight, posterior row strongly procurved; laterals nearer to each other. Ocular quad longer than wide and narrower in front as in text-fig. 8. Clypeus high and vertical. Chelicerae strong, inner margin with four teeth and outer with five teeth; fang unarmed. Sternum heart shaped, pointed behind, clothed with long spiny hairs and scattered spines. Legs light brown with deep brown bands prominent near the ends of segments.

Abdomen : Oval, dark brown to grey, in the mid-dorsal region a longitudinal light brown line from which a number of oblique narrow lines laterals. Sub-lateral regions dar-



Figs. 8-13. *Agelena oaklandensis* sp. nov.
8. Dorsal view of female, legs omitted; 9. Maxillae and labium; 10. Epigynum; 11. Internal genitalia; 12. Lateral view of male palpus; 13. Ventral view of male palpus.

ker longitudinally. Dorsum clothed with prominent hairs. Venter light brown. Anterior spinnerets separate, longer and two segmented. Epigyne as in text-fig. 10. Internal genitalia as in text-fig. 11. Male slender and much smaller; carapace light brown and abdomen lighter and lines not prominent. Male palpus as in text-figs. 12, 13.

Holotype : female *allotype* male.

Type-locality : Oakland, Shillong, India. Coll. *M. Barman*, 22.7.1972.

Discussion : This species resembles *Agelena shillongensis* Tikader in general appearance but differs from it in (i) Abdominal colour, (ii) Anterior median eyes larger than others, whereas in *A. shillongensis* anterior median eyes smaller than others. (iii) Structure of epigyne and male palpus different.

These spiders are commonly found from May onward. They spin funnel like web on bushes usually in the hedges of Duranta, with tube like retreat. During the day they wait near the opening of the retreat and hide very quickly when alarmed. When approached sometimes withdraw their legs and fall down like pebbles to safety. Egg cases are found in July and August, and is cared for by the mother.

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CHOEROSPONDIAS AURICULATA (ANACARDIACEAE) — A NEW SPECIES FROM INDIA[1]

Dali Chandra[2]

(*With a text-figure*)

During the revision of the genera *Pistacia* L. and *Choerospondias* B. L. Burtt, I came across some specimens which needed re-examination of identification. A few of such specimens collected by P. W. Mackinnon, and previously identified as *Pistacia integerrima* Stewart. On careful examinations it proved to be different from *Pistacia* L. Its characters indicate an undescribed species of *Choerospondias* B. L. Burtt.

The genus *Choerospondias* B. L. Burtt was till recently known to be represented in India by only one species, *C. axillaris* (Roxb.) B.

[1] Accepted January 1978.

[2] Central National Herbarium, Botanical Survey of India, Botanic Garden, Howrah-3.

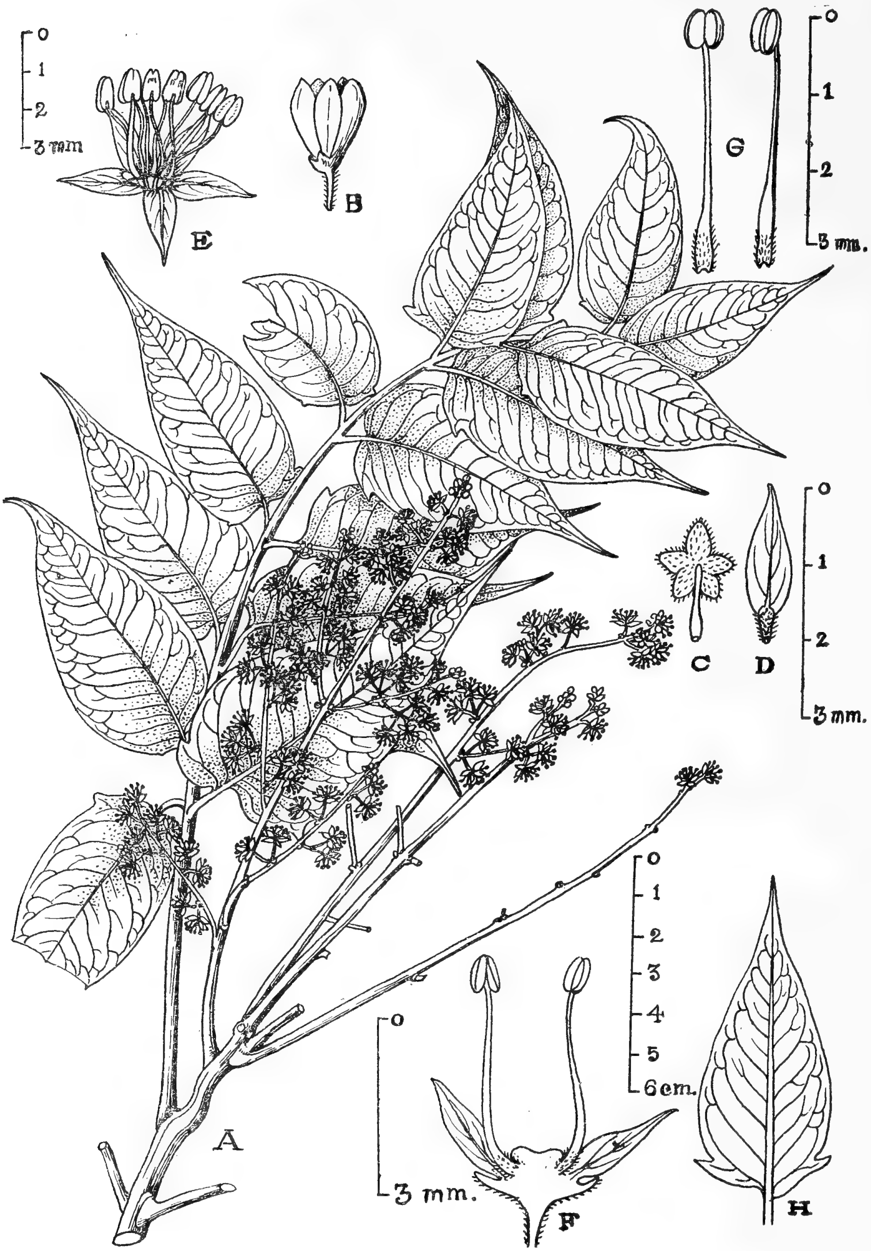

Fig. 1. *Choerospondias auriculata* sp. nov.
A. Twig; B. Bud; C. Calyx; D. Petal; E. Expanded flowers; F. L.S. of flower; G. Stamens; H. Single leaflet.

L. Burtt. One more has been found, collected by P. W. Mackinnon (date: 15-5-1899, without Coll. no.) from Mussoorie, Uttar Pradesh and is named and described here.

Choerospondias auriculata sp. nov.

A *C. axillaris* (Roxb.) B. L. Burtt. Praecipue differt ramulis pubescentibus, venarum paribus lateralibus numero minoribus (6-8), folioliis molliter pubescentibus, foliolibasis auriculata, paniculis in ramulorum extremitatibus verticillatis.

Arbor; ramules teretes, molliter pubescentes, cicatricibus foliorum delapsorum obcordatis manifestis et lenticellis parvis linearibus. Folia alterna imparipinnata, 20-34 cm longa; petioli angularis, 10 cm longi, pubescentes; gemmae axillares parvae, apice tomentosae; foliola 9-13, opposita vel sub-opposita, inferiora superioribus majora, membranacea, ovata, 6-9 x 2.5-4 cm, apice caudato-acuminata, margine integra, basi oblique-rotundata cum auriculata prominenti in quoque latere, paribus venarum 6-8, arcuatis, marginem non attingentibus, supra obscuris et infra prominentibus, utrinque molliter pubescentia, plus ita infra; petioluli rare pubescentes, 0.5-1 cm longi. Panicula terminalis, in ramulorum extremitibus, verticillata, 16-19 cm longa, glabra, axe angulari, ramibreves patentes, flores aggregati in ramulorum extremitibus. Flores unisexualis, regulares, ebracteati. Flores masculus 5 mm diametro per anthesin; pedicellus 1 mm. longus, pubescens. Calyx 5-lobatus, 1 mm diametro, lobis ovatis, imbricatis, parce pubescentibus. Petala 5, libera, oblongo-lanceolata, 2 x 0.6 mm, margine intro curvato, costa singularis prominens et venulae laterales inconspicuae, supra glabra, infra basi hirsuta. Discus 5-lobus, tenuis, 1 mm diametro. Stamina 10, libera, 3 mm. longa, ad basin disci inserta, filamenta filiformia, basis subulatus, antheris multo longiora, ad partem basalem hirsuta, dorsifixa, anthera oblonga, biloba, introrsa, longitudinaliter dehiscens. Carpellum nullum.

Holotypus: Lectus a P.W. Mackinnon ad locum India, U.P., Mussoorie, die 15-5-1899, et positus in herbario indico nationali (CAL) sub numero accessionis 98623.

Choerospondias auriculata sp. nov.

This species differs from *C. axillaris* (Roxb.) B. L. Burtt mainly in its pubescent branchlets, less numerous of vein pairs (6-8), finely pubescent leaflets, prominent auricle on each side of the lamina base and terminally whorled inflorescence axes.

Tree; branchlets terete, softly pubescent with prominent obcordate leafscars and small linear lenticels. Leaves alternate, imparipinnate, 20-34 cm long; petiole angular, 10 cm long, pubescent; axillary bud small, tomentose at apex; leaflets 9-13, opposite or subopposite, lower leaflets larger than upper, membranous, ovate, 6-9 x 2.5-4 cm, apex caudate-acuminate, margin entire, base obliquely round with a prominent auricle on each side, 6-8 vein pairs, arched, not reaching the margin, faint on dorsal side and raised on ventral side, both surfaces softly pubescent but more on ventral side; petiolule thin, 0.5-1 cm long, pubescent, Panicle terminal, whorled at the extremity of the branchlets, 16-19 cm long, glabrous, axes angular, branches short, flowers aggregated at the ends of the ultimate branchlets. Flowers unisexual, regular, ebracteate. Bud obconic, 2 mm in diameter. Male flower 5 mm in diameter when in full blossom; pedicel 1 mm long, pubescent. Calyx 5-lobed, 1 mm in diameter, lobes ovate, imbricate, sparsely pubescent; petals 5, free, oblong-lanceolate, 2 x 0.6 mm, margin inwardly curved, midvein prominent with faint lateral veins, dorsal surface glabrous, hirsute at base on ventral surface; disc 5-lobed, 1 mm diameter, thin; sta-

mens 10, free, 3 mm long, inserted at the base of the disc, filament filiform above subulate at base, much longer than anther, hirsute at base, dorsifixed, anthers ablong, bilobed, introrse, longitudinal dehiscence; no carpel.

Holotype: INDIA: Uttar Pradesh, Mussoorie, 15-v-1899, P. W. Mackinnon *s.n.* (CAL) Acc. No. 98623.

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I am grateful to the Director, Botanical Survey of India, Deputy Director and Keeper, Central National Herbarium, Botanical Survey of India, for facilities; to Dr. N. C. Majumder, Systematic Botanist, Central National Herbarium, for latin diagnosis of the species and to P. R. Sur, Botanical Survey of India, for encouragement.

ASCOMYCETES OF WESTERN INDIA — V[1]

ALAKA PANDE[2]

(*With two text-figures*)

During the examination of mycological collections made from various forests of Western India, two interesting Ascomycetes were identified and determined as new to science, one of which namely *Leptospora* constitutes a new generic record to Indian Fungi.

Leptospora Rabenh.

Hedwigia *1* : 116, 1857

This loculoascomycetous genus is characterised by ascostromata which are immersed to erumpent on herbaceous stems, slightly beaked with bitunicate asci in basal layers, producing brown, filiform, multiseptate ascospores which are of uniform diameter throughout their length and having no constrictions at any septum (Dennis 1968; Luttrell 1973; Holm 1957).

Leptospora indica sp. nov.

(Fig. 1)

Stromata erumpentia, dispersa, nigra, plerumque uniloculana. Pseudothecia subglobosa, ostiolata, rostellata, 360-450 x 640-800 μm. Asci in basilaris strato, brevistipitati bitunicati, paraphysoidibus, clavati, vel cylindrici 130-180 x 16-20 μm. Ascosporae 8, scolecosporae, multiseptatae, brunneae, in spirem contortae, uniformium diametriorum, seine constrictis ad septis, tumida cellula nulla, 120-160 x 3.5-4 μm.

On dead herbaceous stems, dt. 10-7-1971. Leg. D. N. Mhaskar, Type Loc. Sinhagad (Poona), Holotype—AMH 3641.

The present collection when compared with the type species [*L. rubellus* (Pers. ex Fr.) Rabenh.] was found to differ in non-production of stain in substratum as against red pigmentation in the type species and in dimensions.

This constitutes a new generic record for India.

Trematosphaeria Fuckel

Jahrb. Nass. Vereins f. Naturkunde 23-24, 161: 1870.

The pseudothecia are partly immersed in substratum with septate phragmosporous

[1] Contribution No. 632 from the Department of Mycology and Plant Pathology. Accepted January 1978.

[2] M.A.C.S. Research Institute, Law College Road, Poona 411 004.

brown ascospores and asci arranged in basal layers.

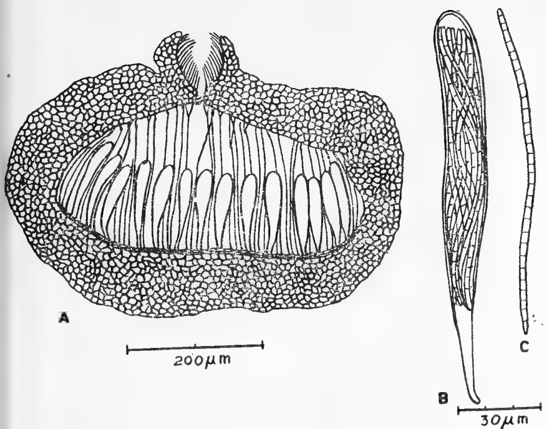
Trematosphaeria graminicola sp. nov.
(Fig. 2)

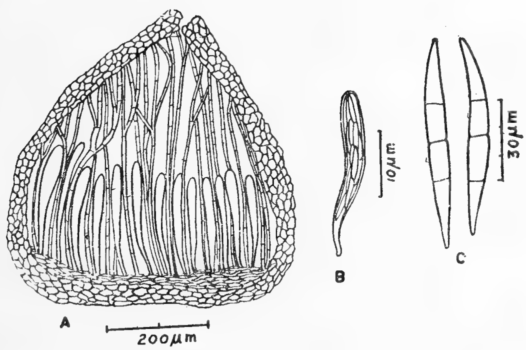
Pseudothecia globosa, erumpentia, parietes 125-160 μm crassi, nigra, ostiolata, 640-700 x 800-900 μm. Ostiolo conico. Asci in basilaris strato, paraphysoidibus, cylindrici vel clavati, brevistipitati, bitunicati, 150-200 x 16-20 μm. Ascosporae 8, brunneae, pallide brunneae ad apices. 3-septatae, fusoideae, apices acutati, distichae ordnatae, 60-80 x 6-8 μm.

On graminaceous host. Type locality—Castle Rock, dt. 20-10-1970, Leg. D. N. Mhaskar, Holotypus AMH 3642.

Four species of this genus have been reported previously from India. The present collection was compared with all these species along with the type and found to be distinct in morphological characters as well as dimensions and is hence described as a new species.

Grateful thanks are offered to Prof. M. N. Kamat, for his interest and guidance and to the Director, M.A.C.S. for facilities.





Above: Fig. 1. *Leptospora indica* sp. nov. A. V.S. Pseudothecium; B. Ascus; C. Ascospores. *Below*: Fig. 2. *Trematosphaeria gramminicola* sp. nov. A. V.S. Pseudothecium; B. Ascus; C. Ascospores.

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JOURNAL, BOMBAY NATURAL HIST. SOCIETY, Vol. 75

A NEW *HOYA* R. BR. (ASCLEPIADACEAE) FROM SOUTH INDIA[1]

A. N. Henry and M. S. Swaminathan[2]

(*With five text-figures*)

Hoya kanyakumariana sp. nov.

Herba epiphytica, pendula; caules scandentes, tereti, verrucati, cinerei, puberuli, demum glabri, radices adventitiae a tota superficie emittentes. Folia 1.5-3.3 x 1.5-2.2 cm, obovata ad obcordata, integra, carnosa, glabra, apice rotundata vel emarginata, basin contracta; nervi et medii et laterales obscuri; petioli 2-6 mm longi, crassi, puberuli, demum glabri. Flores multi, cymis solitariis, umbellatis et lateralibus ad nodos; pedunculi ad 1.6 cm longi, inter petiolos orientes, tereti, crassi, puberuli; pedicelli ad 1.8 cm longi, crassi, minute puberuli, unusquisque cadens pedunculo cicatricem relinquens; bracteae minutae, scariosae. Calyx glaber; lobi 5, unusquisque 1.5 x 1 mm, ovatus, rotundatus, imbricatus. Corolla 1-1.2 cm diam., subroseo-alba, rotata, extus glabra, intus vero tomentosa; lobi 4 x 3 mm, in dimido inferiore partita, ovata, subacuta; margines recurvae. Corona singula, 5-6 mm diam., subroseo-rubra, lobis 5 carnosis; lobi stellatim patenti, infra columnam staminalem adnati, apice liberi; superficies concava, margines interiores cuspidibus super gynostegium incumbentes. Gynostegium breve, sessile. Antherae, connectivo in apicem membranaceam, prodientes; massae pollinis ovatooblongae, in utroque loculo solitariae, ascendentes, margine angusto et pellucido; corpuscula cornea, alata. Ovarium glabrum, pluriovulatum; apex styli inclusus, 5-angulatus, ad medium leviter apiculatus. Fructus non visus.

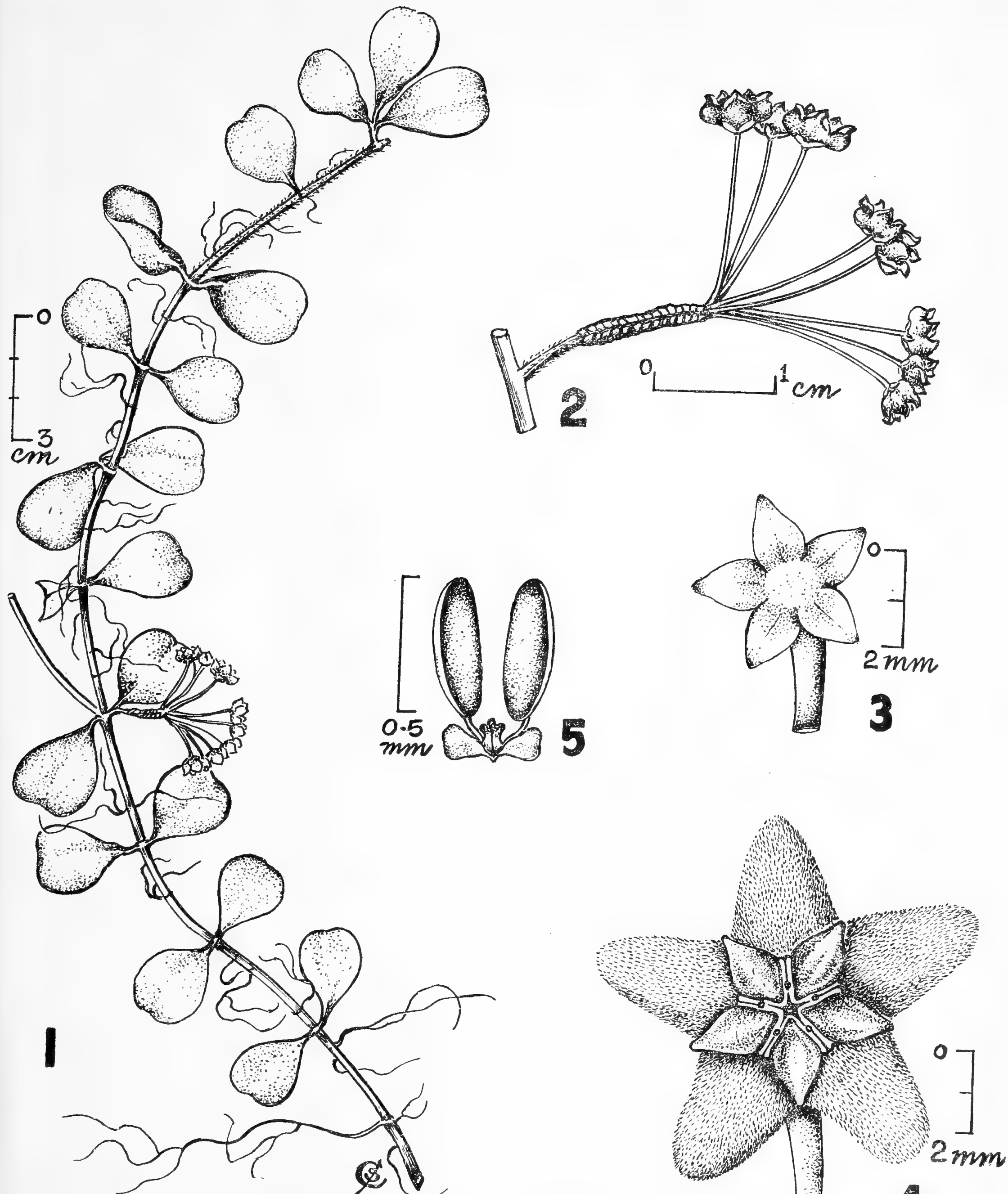
[1] Accepted May 1978.

[2] Botanical Survey of India, Coimbatore - 2.

Hoya kanyakumariana sp. nov.

An epiphytic herb, pendulous; stems climbing, terete, warty, grey, puberulus, at length glabrous, giving out adventitious roots from all over the surface. Leaves 1.5-3.3 × 1.5-2.2 cm, obovate to obcordate, entire, fleshy, glabrous, rounded or emarginate at apex, tapering at base; mid and lateral nerves obscure; petioles 2-6 mm long, thick, puberulus, at length glabrous. Flowers many, in lateral, umbellate cymes solitary at nodes; peduncles up to 1.6 cm long, arising from between the petioles, terete, stout, puberulus; pedicels up to 1.8 cm long, stout, minutely puberulus, each leaving a scar on the peduncle when it falls off; bracts minute, scarious. Calyx glabrous; lobes 5, each 1.5 × 1 mm, ovate, rounded, imbricate. Corolla 1-1.2 cm across, pinkish white, rotate, glabrous without, tomentose within; lobes 4 × 3 mm, divided half way down, ovate, subacute; margins recurved. Corona single, 5-6 mm across, pinkish red, of 5 fleshy lobes; lobes stellately spreading, adnate below the staminal column, free at the tip, the upper surface concave; and the inner margins with cusps imcumbent upon the gynostegium. Gynostegium short, sessile. Anthers with connective produced into a membranous tip; pollen masses ovate-oblong, solitary in each anther locule, ascending, with a narrow pellucid margin; corpuscula horny, winged. Ovary glabrous, many ovuled; style-apex included, pentangular, slightly apiculate at the centre. Fruit not seen.

Holotype (*Henry* 48243A) and isotypes (*Henry* 48243B-I) were collected from Vallachithodu—Lower Kodayar in Kanyakumari



Figs. 1-5. *Hoya kanyakumariana* sp. nov.
1. Portion of plant; 2. Inflorescence; 3. Calyx; 4. Flower: Front view; 5. Pollen-masses.

district, Tamil Nadu at an altitude of about 600 m on 6-ix-1976; holotype has been deposited in CAL and isotypes in MH.

ACKNOWLEDGEMENTS

We are thankful to Dr N. C. Nair, Deputy Director, Botanical Survey of India, Coimbatore for facilities and encouragement, Rev. K. M. Matthew of the Rapinat Herbarium, Tiruchirapalli for rendering the Latin translation, Mr. J. L. Ellis of Central National Herbarium (CAL) for his valuable opinion on the specimen, and Mr. M. Chandrabose, Botanist, B.S.I., Coimbatore for helpful suggestions.

REVIEWS

1. THE WILD CANIDS. Their Systematics, Behavioural Ecology and Evolution. Edited by M. W. Fox. pp. xiv + 508 (15.5 × 22.5 cm.), with black and white photographs. New York, 1975. Van Nostrand Reinhold Company.

THE WILD CANIDS is a much needed scientific document giving behavioural and taxonomic details of all species of animals belonging to the dog family *Canidae*.

The book has 30 chapters, each by a different author including the Editor arranged into five sections, namely, Taxonomic and Morphological Studies, Behavioural Ecology, Social Behaviour, Genetics and Physiology, and Behavioural Evolution.

'The distribution and taxonomy of the canidae', illustrated with good photographs, forms the introductory chapter and this enables the readers to 'meet' the various members of the dog family. The next two chapters of the first section, namely 'molecular approaches to taxonomic problems in the canidae,' and 'the chromosomes of the canidae' are informative. The fourth chapter, deals with sexual dimorphism and geographical distance as factors of skull variation in the wolf. This could have been published in a Journal and the conclusions merely referred to in this book for information. This paper falls outside the scope of this book which requires more comprehensive information. These comments are also applicable to the chapter on the relationships of north American *Canis* shown by a multiple character analysis of selected populations. 'Morphological and ecological variations among grey wolves (*C. lupus*) of Ontario, Canada' is an excellent work, but the reader would have been more benefitted if the remaining races too were covered either in the same chapter or separately. The final chapter in this section namely, 'the origin of dingo: an enigma' is an interesting paper furnishing almost everything that is known about the origin of the dingo—the Australian wild dog.

The second section namely, Behavioural Ecology, includes good information on the Indian wild dog. It also includes varying degrees of interesting information on the behavioural ecology of the Arctic fox, the grey fox, the Pampas grey fox, the large fox, the red fox, the coyote, the red wolf and the wolf. There are also compact chapters on the behavioural ecology of the African and South American canids.

Under the Section of Social Behaviour we have six chapters: two on the feral dog; one each on the golden jackal, the dingo and the wolf; and one chapter on a comparative study of the behaviour of the wolf and the cape hunting dog. The chapter on the dingo namely 'Dingo society and its maintenance' as well as the chapter on the hunting behaviour of two similar species of social canids are well written documents reviewing all information, up to date, an essential requirement for a book of this kind. However, the rest of the chapters in this section are limited observations of the authors which could have been published in a Journal.

The section on Genetics and Physiology contains two papers: 'Genetics of behaviour variations in colour phase of the red fox' and

'Some genetic and endocrine effects of selection for domestication in silver foxes'. These papers too fall outside the scope of this book and it would be desirable to do without these and some others in the next edition.

The final section, contributed by the Editor, comprises a single chapter on the evolution of social behaviour of canids. It is highly informative and comprehensive, and it reviews the hunting techniques, methods of communication and patterns of social organization in the canids.

A portion of the book that considerably enhances its value is the Foreword by Konrad Lorenz. While talking about his favourite subjects: the dingo, the wolf, and the origin of the dog, he imperceptibly carries the readers with him in his pursuit for understanding the dog family—a fascinating group of animals, intimately associated with man from the beginning.

The book is somewhat incomplete and one would expect much more information on many species. However, we should realize that this book is the first of its kind, and should agree with the editor that 'the inadequacies or "holes" in the text are in fact gaps in our knowledge about the social ecology of the canids'. This can be a challenge to the young field biologist to investigate.

Barring the few shortcomings already referred to, the WILD CANIDS is a valuable source of reference for students and scientists. The list of references given at the end of the book is exhaustive and hence valuable for fresh researchers. Even general readers of natural history books will find many of the chapters absorbing reading. The photographs are uniformly good and the paper and binding are excellent.

ROBERT B. GRUBH

2. CONTRIBUTIONS TO ESTUARINE BIOLOGY. (Papers presented at the Third All India Symposium on Estuarine Biology.) Edited by C. V. Kurian. pp. 1008 (25 × 18 cm.), with 30 plates and many illustrations. Cochin, 1975. The Department of Marine Sciences, University of Cochin. Price Rs. 100.00.

Estuaries, at first sight, may not present the fascinating facets that the sea or ocean does. Nonetheless, they harbour some of the richest flora and fauna, both in number and variety, besides serving as breeding grounds for a multitude of marine fishes and commercially important shellfish. If they offer to the casual observer a sore sight, besides offending his sense of smell, it is only because of man's callous ill-treatment, resulting from their being considered as a convenient dumping ground for his wastes—both domestic and industrial.

Journals for publication of papers dealing with marine and fresh-water biology abound; however, the subject of estuarine biology, not falling in either of the aforestated two categories, suffers thereby. By catering to the need, therefore, of workers on estuarine biology, in the form of organizing a symposium on this subject, the Department of Marine Science, University of Cochin, and more particularly Dr. C. V. Kurian, the Editor, have done yeoman service to estuarine biologists.

The specialized subjects in the Contributions range from aquaculture and commercial fisheries to hydrology, plankton, foulers and bor-

ers, physiology, parasitology and bacteriology, thus covering a wide gamut of aspects of life sciences. A review of the individual papers would require a coverage amounting to many pages, so it may suffice to say that most of the papers in the compiled contributions are of a high standard.

Unfortunately the papers on a particular subject have not been grouped together. Thus one finds some papers, say, on plankton, followed by bacterial resistance to an antibiotic, then the use of chlorine to prevent fouling, followed by a few papers on Foraminifera, then a paper on effects of pollution. Had the papers been arranged subjectwise, say commercial fishery, hydrology, laboratory and field aquaculture, pollution, bacteriology, fouling, physiology, etc., the reader would not have had to waste time locating papers of his specialized interest among the scattered literature.

Finally, in the rat-race among Indian scientists to have their manuscripts published early, papers—albeit excellent in quality by themselves—that deal with marine life have also been included in the present compilation. It is fortunate for the authors that the plant or animal they have worked on happens to tolerate estuarine conditions. Glaring examples are the papers on marine bacteria, laboratory culture of crustaceans in seawater of "normal" salinity (i.e. 35 to 37.5‰), or field culture in salt pans (salinity 38 to > 39‰).

The papers show careful and laborious editing, and the printing has been done on good quality paper, so that the contributions, running to over a thousand pages, are worth the price of Rs. 100/- in these days of expensive printing.

B. F. CHHAPGAR

3. THE FLORA OF EASTERN HIMALAYA + Third Report: Compiled by Hiroyoshi Ohashi. pp. xv + 458 (26 × 19 cm.), with 33 plates (including 7 coloured plates), and 82 illustrations. Japan, 1975. University of Tokyo Press. Price Yen 8200.

This publication, the third of the series on the subject contains reports by 21 scientists and their collaborators of the fifth botanical expedition to the Eastern Himalayas in 1972, organised by the University of Tokyo. It also includes reports on collections made by Dr. Hiroo Kanai during his stay in Nepal from 1969 to 1971 as a Colombo Plan Advisor to the Department of Medicinal Plants of His Majesty's Government of Nepal; and contains data supplementary to the preceding two reports. Critical comparative studies on corresponding taxa in Japan and Himalayas have continued in this volume.

Besides systematic enumeration of plants collected—Spermatophyta, Pteridophyta and Bryophyta—this volume also contains the following critical revisions:

1. A revision of the Eastern Himalayan Species of the Subgenus Rhodiola of the genus *Sedum* (Crassulaceae) by Hideaki Ohba.
2. The genus *Hedysarum* (Leguminosae) in the Himalayas, by Hiroyoshi Ohashi and Yoichi Tateishi.
3. A revision of the genus *Helwingia* by Hiroshi Hara and Sachiko Kurosawa.

A very interesting and exhaustively documented (58 tables) article on 'Vegetation Survey of Central Nepal' by Hiroo Kanai, Pushpa

Ratna Shakya and Tirta Bahadur Shrestha, is also included.

This volume stands on par with the previous two in the excellence of botanical reports and the production values. The photographic reproductions of *Helwingia* and all the other taxa are fascinating and make very valuable contributions to the botanical studies of this montane region. How one wishes that at least a few of the Universities or other Institutes in India will bring out similarly illustrated reports of the vegetable wealth of India!

P. V. BOLE

MISCELLANEOUS NOTES

1. LIST OF NATIONAL PARKS AND WILDLIFE SANCTUARIES IN MADHYA PRADESH

(*With a text-figure*)

Madhya Pradesh with forested areas, totalling 37.52% of the area of the state, has so far established 3 national parks and 15 wildlife sanctuaries duly notified under the Wild Life (Protection) Act, 1972 (Anon, 1976). There are 10 more areas which are not yet constituted as wildlife sanctuaries but are under process of notification and development. There were 9 wildlife sanctuaries which existed prior to enactment of Wild Life (Protection) Act, 1972 and were originally notified under Forest Rules. These 9 wildlife sanctuaries have not been found useful and therefore no action has been taken so far to renotify them under the present Act. The national parks and wildlife sanctuaries are scattered all over Madhya Pradesh. Out of 45 districts, the 3 national parks are spread over 4 districts. The 15 existing notified wildlife sanctuaries occur in 13 districts of which Raipur and Raigarh have 2 wildlife sanctuaries each. Ten proposed wildlife sanctuaries are distributed in 8 districts with one wildlife sanctuary in each district except for Raipur and Sarguja where 2 wildlife sanctuaries are proposed. The old and now non notified 9 wildlife sanctuaries existed in 4 districts, 1 in Rewa, 3 in Sidhi, 3 in Panna and 2 in Shahdol. The following are the list of national parks and wildlife sanctuaries existing, proposed, and dropped, with their location in the forest division, district and their legal status.

TABLE 1

LIST OF NOTIFIED NATIONAL PARKS EXISTING IN MADHYA PRADESH

National Park/Wildlife Sanctuary	Forest division	District	Declared under Old Rules/Present Act	Remarks
1. Kanha National Park	Kanha National Park	Mandla/ Balaghat	Present Act	The park is now under Tiger Project
2. Madhav National Park	Shivpuri	Shivpuri	-Do-	–
3. Bandhavgarh National Park	Umaria	Shahdol	-Do-	–

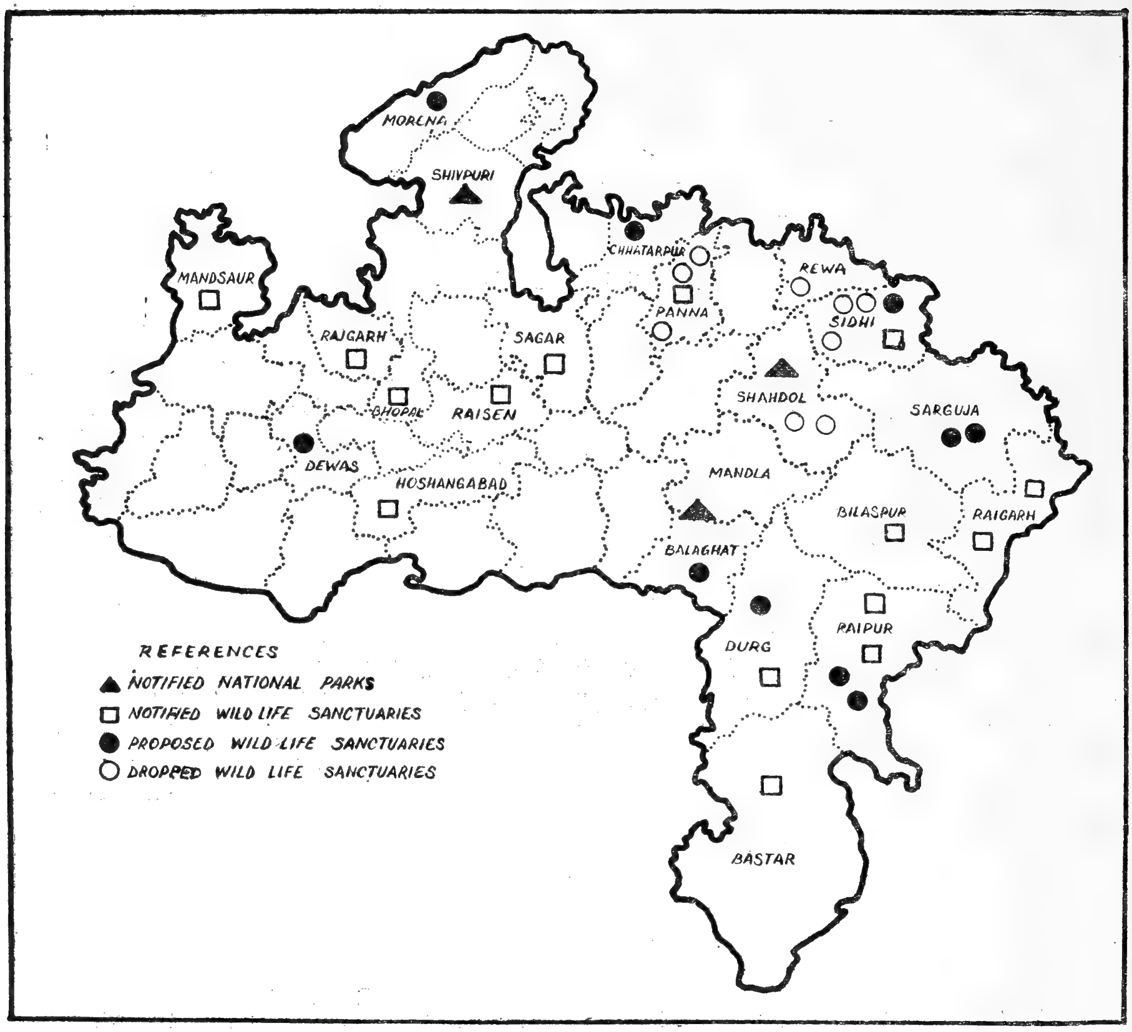


Fig. 1. Map of Madhya Pradesh showing the distribution of National Parks and Wildlife Sanctuaries in various districts.

TABLE 2

LIST OF NOTIFIED WILDLIFE SANCTUARIES EXISTING IN MADHYA PRADESH*

National Park/Wildlife Sanctuary	Forest division	District	Declared under Old Rules/Present Act	Remarks
1. Narsinghgarh Wildlife Sanctuary	Sehore	Rajgarh	Present Act	–
2. Gandhi Sagar Wildlife Sanctuary	Indore	Mandsaur	–Do–	–
3. Sitanadi Wildlife Sanctuary	South Raipur	Raipur	–Do–	–

4. Noradehi Wildlife Sanctuary	South Sagar	Sagar	-Do-	–
5. Bori Wildlife Sanctuary	Hoshangabad & Sohagpur	Hoshangabad	-Do-	–
6. Achanakmar Wildlife Sanctuary	Bilaspur	Bilaspur	-Do-	–
7. Dubri Wildlife Sanctuary	West Sidhi	Sidhi	-Do-	–
8. Badalkhol Wildlife Sanctuary	Jashpur	Raigarh	-Do-	–
9. Gomarda Wildlife Sanctuary	Raigarh	Raigarh	-Do-	–
10. Gangau Wildlife Sanctuary	North Panna	Panna	-Do-	–
11. Kutru Wildlife Sanctuary	South Bastar	Bastar	-Do-	–
12. Sispur Wildlife Sanctuary	Mahasamund	Durg	-Do-	–
13. Ratapani Wildlife Sanctuary	Bhopal	Bhopal	-Do-	–
14. Barnawapara Wildlife Sanctuary	North Raipur	Raipur	-Do-	–
15. Sindhori Wildlife Sanctuary	Raisen	Raisen	-Do-	–

* Duly notified under present Act, 2 wildlife sanctuaries of Balaghat district namely, Maikal and Supkhar have been merged with Kanha National Park in 1976.

TABLE 3

LIST OF WILDLIFE SANCTUARIES PROPOSED FOR NOTIFICATION UNDER THE WILD LIFE (PROTECTION) ACT, 1972

National Park/Wildlife Sanctuary	Forest division	District	Declared under Old Rules/Present Act	Remarks
1. Kheoni Wildlife Sanctuary	Dewas	Dewas	Old Rules	Proposal awaited from D.F.O. for getting it notified under the Act.
2. Torenga Wildlife Sanctuary	East Raipur	Raipur	-Do-	-Do-
3. Shiksasar Wildlife Sanctuary	East Raipur	Raipur	-Do-	Proposal under scrutiny for notification under the Act.
4. Rangakhar Wildlife Sanctuary	Kawardha	Durg	-Do-	Proposal awaited from D.F.O. for getting it ontified under the Act.
5. Balaghat Bird Sanctuary	Balaghat	Balaghat	-Do-	-Do-
6. Kuno Wildlife Sanctuary	Sheopur	Morena	-Do-	-Do-
7. Khajuraho Wildlife Sanctuary	Chhatarpur	Chhatarpur	-Do-	-Do-

8. Pingla Wildlife Sanctuary	Sarguja	Sarguja	–Do–	Proposal under scrutiny for notification under the Act.
9. Udaipur Wildlife Sanctuary	South Sarguja	Sarguja	–Do–	Proposal submitted to Govt. for notification under the Act.
10. Ramdaha Wildlife Sanctuary	West Sidhi	Sidhi	–Do–	–Do–

TABLE 4

LIST OF EXISTING WILDLIFE SANCTUARIES NOTIFIED UNDER OLD FOREST RULES BUT NOT UNDER THE WILD LIFE (PROTECTION) ACT, 1972

National Park/Wildlife Sanctuary	Forest division	District	Declared under Old Rules/Present Act	Remarks
1. Shikarganj Block II Wildlife Sanctuary	North Shahdol	Shahdol	Old Rules	–
2. Shikarganj Block III Wildlife Sanctuary	North Shahdol	Shahdol	–Do–	–
3. Shikarganj Block I Wildlife Sanctuary	West Sidhi	Sidhi	–Do–	–
4. Shikarganj B Wildlife Sanctuary	West Sidhi	Sidhi	–Do–	–
5. Majholi Wiidlife Sanctuary	West Sidhi	Sidhi	–Do–	–
6. Siri Wildlife Sanctuary	South Panna	Panna	–Do–	–
7. Talegram Wildlife Sanctuary	South Panna	Panna	–Do–	–
8. Shyamgiri Wildlife Sanctuary	South Panna	Panna	–Do–	–
9. Narohil Wildlife Sanctuary	Rewa	Rewa	–Do–	–

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I am thankful to the Director, Zoological Survey of India and to Officer in Charge, Central Regional Station, for the facilities. I am also grateful to Dr. S. D. N. Tiwari, Chief Conservator of Forests and to Shri J. J. Dutta, Chief Wildlife Warden, Madhya Pradesh for the cooperation provided by them.

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July 4, 1977.

2. ON THE OCCURRENCE OF HORSFIELD'S SHREW, *CROCIDURA HORSFIELDI* (TOMES) IN PENINSULAR INDIA

While making a collection of small mammals for chromosomal analysis, we came across a few individuals of small shrews under litter, grass heaps and other waste materials in the University campus (Manasa Gangotri, Mysore, S. India) in July 1976. These specimens were identified by the British Museum (Natural History), London, as *Crocidura horsfieldi* Tomes. Ellerman and Morrison-Scott (1951) have mentioned the approximate distribution of this species in Ceylon, Kashmir, Indo-China, Siam, Northern Burma and Liukiu Islands (page 75). The occurrence of this genus has not so far been recorded from peninsular India and this is the first report of the occurrence of this species from this region. This species resembles the pygmy shrew, *Suncus etruscus* in appearance. But, *Crocidura horsfieldi* is slightly larger than *Suncus etruscus* in size. The average body measurements of the Horsfield's shrew, *Crocidura horsfieldi* are: Head and body = 61 mm; Tail = 47 mm; Hind foot = 11 mm; and Ear = 7 mm. So far fifteen specimens of both the sexes have been collected in the environs of the University campus.

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3. PARTURITION IN THE INDIAN RUFOUS BAT, *RHINOLOPHUS ROUXI* (TEMMINCK)

The natural inverted resting posture of the bats has resulted in unique behavioural adaptations of these animals during parturition and makes the study of this process a very fascinating one since the young has to be ejected against gravity. Unfortunately the details of this interesting aspect of the biology of the bats is known with respect to very few species although this is one of the largest groups among mammals including over a hundred genera and several hundreds of species (Simpson 1945). Even among the few species of bats in which parturition has been studied there are interesting differences with regard to the posture the mother assumes during labour and the behaviour of the mother and the young one during and immediately after delivery. Whereas delivery occurs while the mother hangs in the normal inverted posture in a few species (Ramakrishna 1949, 1950; Gopalakrishna *et al.* 1976) the mother normally reverses her natural posture during delivery in *Myotis lucifugus lucifugus* (Wimsatt 1960). In *Pipistrellus ceylonicus chrysothrix* (Gopalakrishna & Madhavan 1972) and some times in *Myotis lucifugus lucifugus* (Wimsatt 1960) the mother hooks her toes and also her wings to the ceiling so that her body assumes a cradle-like structure during labour. Further, while in most cases the young are delivered by breech presentation (Sherman 1930, 1937; Wimsatt 1945, 1960; Gopalakrishna & Ma-

dhavan 1972) delivery by head presentation occurs in a few species (Ramakrishna 1949, 1950; Gopalakrishna *et al.* 1976). Since there is no information regarding parturition in any rhinolophid bat it was felt that a study of this process in *Rhinolophus rouxi* would be of interest and value.

The present description is based on the observation of parturition in seven specimens of *Rhinolophus rouxi* during the first week of May. Full term pregnant specimens were brought to the laboratory early in the morning and they were kept under continuous observation in a wire cage. In all the cases the delivery occurred late in the afternoon on the same day on which the specimens were brought to the laboratory.

After a short period of restlessness after being released into the cage the mother quietened and hooked her toes to the wire mesh at the roof of the cage and remained hanging freely until about an hour before the onset of labour except for occasional shifting of her position inside the cage. On the approach of labour the mother became restless and constantly shifted her position in the cage. This was a definite indication of impending delivery in all the cases. After a few minutes of such restlessness she finally settled in one place and did not normally change her position in the cage unless she was disturbed by some sound or movement in the laboratory. Before the onset of labour the mother hooked her toes to the wire mesh with her hind limbs kept wide apart. The onset of labour was indicated by alternate dilatation and contraction of the vulval opening accompanied by the mother bending her neck acutely ventralwards and frequently licking the vulval opening. Often the mother would bend her head dorsally as if to streatch her abdomen before suddenly bending ventrally as if to press her abdomen. After a few sharp contractions of the body in six of the seven cases observed here the head of the young one was seen to emerge out of the vulval opening. By constant licking of the emerging head and by actively biting the amnion with her teeth the mother tore off the amnion and licked away the oozing amniotic fluid. The head emerged with its crown first and slowly the rest of the head, shoulders and the rest of the body of the young one emerged out of the vulval opening. The young one was born with its ventral surface facing the abdomen of the mother. The entire process of parturition beginning with the first sign of labour as revealed by the dilatation of the vulval opening until the ejection of the young took between 30 to 40 minutes. In all the cases the mother severed the umbilical cord by biting it off and freed the young. The new born young is flesh coloured, nearly naked and has adherent eyelids. The weight of the young ranged between 1.8 and 2.1 gm. After complete emergence, the young became active and crawled towards the thoracic mammary nipples of the mother and attached itself firmly to one of the nipples with its mouth and immediately showed sucking movements of the lips and the jaw muscles.

The placenta was extruded half to two hours after the delivery of the young one and in four cases the mother chewed and ate up the placenta. In the rest of the cases the placenta dropped to the floor of the cage, and the mother took no further notice of it.

In one case the young was delivered with its hind limbs emerging first followed slowly by the rest of the body. The behaviour of the mother in this case, however, was similar to that of the cases described above.

In all the cases the mother retained her freely hanging posture with her two legs wide apart during the entire period of labour, and

in all the cases the mother actively used her wings as a barrier to prevent the accidental dropping away of the young one after its emergence.

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4. PATERNAL BEHAVIOUR OF THE RHESUS MACAQUE, *MACACA MULATTA* IN NATURE

Much information is available on the maternal behaviour of the rhesus macaque, *Macaca mulatta* (Zimmermann) but little is known about its paternal behaviour, particularly in nature, and the available information is summarised in Hrdy (1976) and Roonwal & Mohnot (1977).

During a nine-month field study of the rhesus macaque from January to October 1976, in the Asarori Forest near Dehra Dun, Northern India, I came across some instances of paternality, and can categorise these behaviours under two main headings:

A. **Active paternality:**

In this type the male directly indulges in the care and fostering of an infant. That is, he holds, carries, grooms and protects from other monkeys and dangerous situations and roosts with it.

Two such cases were observed in a big group of about 90 individuals:

Case 1: The leader male showed paternal care of an 8-month old male infant over a period of about five months during which I observed the dyad for a total of seven days (3 days in February and 2 each in April and June). The first instance was obsered on 22 Feb. after an intra group struggle at 4.05-4.20 p.m. The leader carried (ventro-ventrally), held, "reassured" and roosted with the infant. Episodes of the paternal behaviour decreased with time. Occasionally when some males and females of the group were threatened by the leader, they transferred the threat to the

infant; at this the male again threatened them.

Case 2: An adult lower ranking male sometimes carried (ventro-ventrally), held and protected a nearly 5-month old female infant. When the mother (considered abnormal due to a surgical operation) rejected or avoided the infant, the latter approached and followed the male.

B. **Passive paternality:**

In this type on the screeching or screaming of an infant, the leader male forced the mother by threat and/or chase, to take care of the infant. Occasionally a lower ranking male (Beta Male) of a group (size 31) showed a similar behaviour. The leader also threatened the observer, while consistently looking at infant or approaching a mother with infant.

Thus a great variation is found in care and quality of paternal behaviour with the individual monkey, however, passive paternality was observed in most of the group leaders.

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5. RECENT SIGHTINGS OF *MACACA SILENUS* (LINNAEUS, 1758), AT MASTIMANE GHAT, NORTH KANARA DIST., KARNATAKA

Macaca silenus (Liontailed Macaque) is a rare and unique species of primate inhabiting the evergreen forests on the upper elevations of the Western Ghats from North Kanara in Karnataka southwards to Kerala (Blanford 1888; Prater 1948).

Hitherto the observations have been restricted to the southern part of its ecogeographic range (Sugiyama 1968; Krishnan 1971; Karr 1973 and Pruett 1973). Sugiyama recorded the species in Nilgiri, Annamalai and Cardamom Hills and in the vicinity of Periyar Lake, between 9°31′ and 11°30′ N. Krishnan limits its range to a few evergreen forests of the Western Ghats in Tamil Nadu and Kerala. This note presents first hand information on the status of a troupe of *Macaca silenus* at Mastimane Ghat on the right bank of Sharavati river in North Kanara district, Karnataka.

Earlier in 1966 Virus Research Centre, Field Station at Sagar obtained an adult male specimen trapped by a resident of Kuggve village 20 miles east of Mastimane. How the animal strayed into the village is not known. The known habitat of the species is about 20 miles west of Kuggve. The monkey lived in captivity at Sagar, partly at VRC Field Sta-

tion and partly at the local College, till it was transferred to Wild Life Park at Bannerghatta in 1974.

The first sighting of a troupe in its natural habitat was made on 3rd April 1973 in Mastimane Ghat on the right bank of Sharavati river on the Bangalore-Honnavar Road at about 160 m from sea level. The troupe was slowly moving on the trees on the road side. As soon as the vehicle was stopped they crossed the road and entered deep forest. There were 18 animals of different age including a female with an infant. Second sighting was made in the early part of 1975 by the monkey trappers hired by the forest department for trapping a mate for the male taken to the Wild Life Park at Bannerghatta. The trappers reported that the troupe had 13 individuals, three individuals of the troupe were surrounded and one juvenile female was trapped. The first author accompanied Dr. Steven Green of Rockefeller University, New York in 1975 and made an enquiry about its homing range. It was gathered from the local people that the troupe has been generally sighted between the miles 242 and 247 along the Bangalore-Honnavar Road. The home range is estimated to be between 14°16′ to 14°18′ N. and 74°42′ to 74°44′ E.

The latest sighting was made on 11th August 1977 at 09.00 hrs at the same location. The troupe was slowly moving from road side down into the valley. Only the rear part of the troupe was sighted and 10 adults and juveniles were counted. The number in the front part of the troupe could not be estimated.

Prater (1948) records that the species inhabits the tropical evergreen forest belt between 615 to 1070 m (2000 and 3500′), Sugiyama (1968) between 800 to 1300 m. However both the sightings by the present authors were made at 160 m and the highest elevation in the estimated home range reaches about 770 m.

The terrain has steep ridges and deep ravines clad with evergreen and semievergreen forests. The habitat of the monkey has been abused since 1958 by selective felling operations and encroachment by needy agriculturists. Another possible factor which threatens this species is Kyasanur Forest disease which has been rampant during the last four years in the forests of the immediate neighbourhood. However, as yet the susceptibility of *Macaca silenus* to Kyasanur Forest disease is not known. The other two species of monkeys, *Macaca radiata* and *Presbytis entellus* have been known to be highly susceptible to Kyasanur Forest disease and hundreds of monkeys succumb to this disease every year.

VIRUS RESEARCH CENTRE,
INDIAN COUNCIL OF MEDICAL RESEARCH,
POONA-411 001,
September 3, 1977.

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M. A. SREENIVASAN

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6. THE RUSTY-SPOTTED CAT, *FELIS RUBIGINOSA* I. GEOFFROY, IN JAMMU AND KASHMIR

The Rusty-spotted Cat, *Felis rubiginosa* I. Geoffroy is one of the little known lesser cats of India. Judging from the few specimens preserved in the British Museum and from the failure by the collectors of the Mammal Survey to collect it, Pocock (1939) opined that this species is 'apparently rare' in India. In recent years several surveys were conducted by the Zoological Survey of India in different parts of the country with special reference to mammals, but not a single specimen of this species could be seen or collected till 1975, which warrants that the Rusty-spotted Cat is indeed very scarce and probably one of those species whose number is gradually decreasing. So far this interesting cat is recorded only from certain localities in southern India and Sri Lanka (Jerdon 1867, Blanford 1888, Pocock 1939, Prater 1965, Ellerman and Morrison-Scott 1966). Sterndale (1884) recorded it from Seoni in Madhya Pradesh, but Blanford mentioned that it appears to be very rare so far north. Jerdon stated that 'in the British Museum there is a specimen stated to be from Malacca, but Mr. Blyth is inclined to think this a mistake.'

During the faunistic survey of Jammu and Kashmir in 1975, the author collected an example of this species from Jammu region. The occurrence of this species in Jammu and Kashmir region is a matter of great interest and indicates that though very rare, its range extends much further north in India. A short note on this specimen is appended. Measurements are taken after Pocock and given in millimetres, and the colours according to Ridgway's (1886) nomenclature.

Felis rubiginosa I. Geoffroy

Felis rubiginosa I. Geoffroy, 1831, *Belanger Voy. Indes Orient. Zool.*, 140 (Pondicherry, southern India).

Material:

1♀ : Jhajjar Kotli, Udhampur, Jammu and Kashmir; 16 Oct. 1975.

Measurements:

EXTERNAL: Head and body 370; tail 200; hindfoot 86; ear 32.

CRANIAL: Total length 67.8; zygomatic width 47; postorbital width 23.7; interorbital width 11.7; maxillary width 17.3; mandibular length 43.7; pm^4 7.8; m 5.5.

Remarks:

Fur short but soft, smooth and woolly. Ground colour above from head to tail tip and on the outside of limbs smoke gray, but more drab-gray in regions of head, back and tail. Hands pale buff. External surface of ear dark brown with an usual large pale spot on each. There is a small tuft of white hairs (12-13 mm long) at the base of each ear. Pattern and colour of other parts of body exactly tallies with the description of the South Indian population of this species given by Blanford and Pocock. Apart from size, Pocock mentioned a number of cranial differences be-

tween this species and *Felis bengalensis* Kerr, namely 'shortening of the upper jaw, accompanied by the downward curve of the end of the nasals and the nearly vertical plane of the anterior nares and of the maxillo-premaxillary suture; also the maxillae are greatly expanded above and the nasals strongly constricted in their posterior portion;....and as an accompaniment of the shortening of the muzzle the area behind the upper canine is also short and has lost the normal small premolar in front.' All the above mentioned differences hold good for the present specimen, but from a cursory examination of the 19 skulls of *F. bengalensis* present in the Zoological Survey of India collection it is found that in three skulls the maxillo-premaxillary suture is nearly vertical and in one specimen anterior small premolar is absent.

The present specimen is an young adult and appears to be slightly smaller than those from South India and Sri Lanka.

Jerdon stated that 'this pretty little cat frequents grass in the dry beds of tanks, brushwood, and occasionally drains in the open country and near villages, and is said not to be a denizen of the jungles'. The present specimen was first noticed at about 23.00 hours in an open scrub forest, with low thorny bushes and stunted trees about one and half kilometres away from the nearest human habitation. When chased, it ran for a certain distance and then climbed very quickly up a tree (about 4 metres high) from where it was shot. Its stomach contained no food. No additional specimen could be seen, though attempts were made to find more during the next five days.

ZOOLOGICAL SURVEY OF INDIA,
8, LINDSAY STREET,
CALCUTTA 16,
January 16, 1978.

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7. CENSUS OF BLACKBUCKS IN THE VELAVADAR NATIONAL PARK OF GUJARAT STATE

INTRODUCTION

Blackbucks are now mostly found in scattered groups in the coastal plains of the Saurashtra region of Gujarat State. However, except in the coastal area known as 'Bhal', the number of animals found in different pockets is very small. In the Bhal area of

Bhavnagar and Dhandhuka Talukas, large herds of blackbucks still occur. To protect these herds, a Sanctuary for blackbucks in the 890 ha. Government Vidi area at Velavadar was established in the year 1969 and in the year 1976, the whole of the Velavadar Vidi area admeasuring 1783.88 ha. was constituted into a National Park for blackbuck. This National Park is situated about 70 km. north of Bhavnagar off the highway to Ahmedabad. For want of camping facility, the Park has not been thrown open for general visitors so far. However, a forest lodge is now under construction and by next year, the general public will be able to visit this unique area for viewing blackbuck.

When the Velavadar Sanctuary was first constituted, it was roughly estimated to contain about 400 blackbuck. With adequate protection, these continued to multiply at a rapid rate. However, in the first week of June 1976, there was a severe cyclonic storm accompanied by heavy rain which continued for more than five days in the Bhal area and as many as 923 blackbuck died due to prolonged exposure and starvation. It therefore became necessary to know the exact number of blackbucks left in the National Park. It was decided to carry out a systematic and detailed census of blackbuck in the National Park area (including the surrounding villages where some of the animals are known to stray) during the summer of 1977. The 5th of May 1977, was finally fixed as the date for the census. The Wildlife Conservation Society of Bhavnagar was associated with the census and nine members of the Society volunteered to work as enumerators.

Method of Census:

The area of the Park was divided into convenient blocks and counting animals in each block was done by the enumerators moving on foot.

Black-bucks are known to commonly stray out of the National Park area into the surrounding villages. It was therefore decided to include 24 villages surrounding the National Park in the census operations.

The area of the National Park (including its buffer zone) was divided into 30 enumeration blocks. These blocks were demarcated on the ground by fixing bamboo poles with white flags. Outside the National Park Zone, each village was constituted as one block for the purpose of enumeration. As the village boundaries are known to the local persons (enumerators), it was not considered necessary to demarcate the boundaries of such blocks.

The whole area was divided into the following zones:

Zone No. 1 National Park Zone (including Buffer Zone) with 30 blocks

Zone No. 2 Mewasa Zone consisting of 11 villages, i.e. with 11 blocks

Zone No. 3 Bavaliyali Zone containing 13 villages, i.e. with 13 blocks

The Census:

There was a heavy thunderstorm on 4th evening which blew off the roof of the watch-tower in the National Park. The ground had also become wet, making it difficult for vehicles to move about freely. However, as the animals were to be counted by moving on foot, there was not likely to be much practical difficulty in carrying out the census.

The census operation was conducted in the National Park Zone between 8.00 to 8.30 and recounting of the animals was carried out from 8.30 to 9.00 hours. After the census operation was over, it was decided to recheck

the counting of animals in the whole National Park Zone by sending out three independent checking parties moving in vehicles and counting the animals with the aid of binoculars. For this purpose, the National Park Zone was divided into three sub-zones by prominent features and one checking party was assigned to each sub-zone. The census result is reproduced below:

	No. of Blackbucks			
	Male	Female	Young ones	Total
National Park (including buffer zone)	338	1052	164	1554
Surrounding villages	31	72	19	122
	369	1124	183	1676

As suggested by Shri M. K. Shivbhadrasinhji, of the Wildlife Conservation Society a census of blackbucks was also carried out separately in Dhankaniya Vidi of Botad Taluka situated about 50 kms. from Velavadar where also blackbucks were reported to occur. The result of this census is as under:

Male	Female	Young ones	Total
39	104	98	241

However, as this area is a separate entity, these figures are not included in the official census figures for Velavadar National Park.

In addition to the above, small herds of blackbucks are unofficially reported at the following places:

Some blackbucks are also known to occur in and around the Rann of Kutch. Thus it is estimated that the present total population of blackbucks in the whole of Gujarat State may be roughly around 2500.

Discussion of the data and Conclusions:

The following conclusions can be drawn from the result of the census:

(1) There is roughly 1 blackbuck to every hectare of the National Park area.

(2) More than 92% of the animals are found in the National Park area while less than 8% of animals are found in the surrounding villages in the morning hours. Generally small herds of blackbuck and solitary males go outside the National Park.

(3) The sex ratio of male to female is roughly 1:3. Normally it should be 1:6. There is thus a preponderance of males in the area. This clearly indicates the urgent need for culling or translocation of the surplus animals.

(4) The young ones make up more than 10% of the population which can be considered to be a very satisfactory breeding rate.

(5) Conducting census by moving about in vehicles and counting the animals with the aid of binoculars has given about 90% accuracy. This method is cheap and can be adopted for preparing rough estimates of animals every year. The elaborate method of dividing the area into enumera-

Bhavnagar District	:	Near Victor Port	.. 40
Amreli District	:	Near Rajula	.. 25 to 30
		Near Damnagar	.. 15 to 20
		Near Lathi	.. 15
Junagadh District	:	Near Jhanjhmer	.. 20 to 25
		Near Kotda	.. 50
Surendranagar District	:	Near Limdi	.. 150
Vadodara District	:	Sunderpura	about 150
		Total about	.. 500

tion block and counting of the animals in each block by enumerators moving on foot may be adopted only at intervals of three to five years.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to M. R. Shivbhadrasinhji and his band of wild life enthusiasts for their active participation in the blackbuck census. The local staff also deserve all praise for the systematic and disciplined manner in which they performed the tasks assigned to them.

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8. LOST PELICANRY

The Spottedbilled or Grey pelican (*Pelicanus philippensis* Gmelin) was first recorded in India well over a century ago (Blyth 1844—quoted by Lamba 1963) and is known to frequent well watered tracts throughout the country. However, for a long time very little was known regarding its breeding in India. Earlier ornithologists believed that the bulk of the Grey pelicans found in India went to Burma to breed (Hume 1890). In later years only two small breeding colonies were reported. One at Buchepalle, Cuddapah District, Andhra Pradesh and another at Kundakolam, Tinnevelley District, Tamil Nadu (then Madras Presidency) (Campbell 1902, Rhenius 1907). Thus the question "where do pelicans breed in India?" had remained to a greater extent unanswered until Neelakantan (1949) discovered, perhaps, the largest pelicanry of India near village Aredu, West Godavari District, Andhra Pradesh. He stated "According to the villagers this sanctuary has been in existence from time out of mind". He also roughly counted more than 800 adults and 1200 chicks of Grey pelicans, in March 1949. Lamba while studying the nidification of this species at the same site, in 1956-57, discovered some more pelicanries in the close vicinities and called them all the "Kolleru Pelicanries". During that period, I was a member of the field team and had seen hundreds of Grey pelicans nesting on palmyra trees. Gee (1960) had counted not less than 3,000 pelicans in an area of two square miles at the same spot. Spillett (1968) made a very brief mention of these pelicanries in his report on the survey of wildlife in South and West India. Since then no information seems to have been recorded on these pelicanries.

I had an opportunity to visit this area again after 18 years between 4th December 1974 and 4th February 1975. To my dismay, not a single pelican was found nesting or otherwise.

Enquiries from the local people revealed that pelicans have stopped coming to this area for breeding for the last few years. One old man informed me that sometime in 1964, birds died in large numbers and since then, the pelicans have disappeared. Some other villagers and one educated farmer from Akividu confirmed the deaths, but said that they were mostly among paddy-birds and egrets. None of them were sure whether pelicans also died. Some of these people suggested that the deaths may have been due to endrin poisoning and

claimed that even fishes, frogs and crabs had died. They informed me that a heavy dose of endrin was used on paddy crops, during that period. There was no way to check the authenticity of these reports and the exact year of the reported large scale deaths.

Later, during August-September 1975 and July-August 1976, while looking for heronries, I had covered an area of about 15 miles radius around Kolleru lake. We located quite a few cattle egrets, little egrets, paddybirds and little cormorants, breeding either in mixed or pure colonies. A search was made for pelicans also by making enquiries from the local people and scanning possible habitats. No pelicans were observed. A nomadic poacher who was well aware of heronries in the area had not seen any pelicans. The enquiries were aided by showing pictures of pelicans and other birds to villagers from the HANDBOOK OF BIRDS OF INDIA AND PAKISTAN by Salim Ali and S. D. Ripley (1968).

Apart from the Kolleru area, we twice visited the rivers Krishna and Godavari near Vijaywada and Narsapur respectively, and the Nagarjunasagar Dam once as possible alternative breeding sites, but could not see or get any information on pelicans.

Apparently the Spottedbilled or Grey pelicans have deserted their traditional home at the Kolleru lake, as my first visit was during the known breeding season (October-April) when no pelicans were seen and even though the later trips were in July and September, it is unlikely that the villagers would miss such a large bird.

I wonder why pelicans have disappeared from Kolleru lake and where they have gone? The disappearance of these magnificient birds must have been the effect of change in the ecosystem brought about by human interference.

The palmyra trees on which most of the pelicans used to nest, have been cut down and replaced by coconut palms. As the weight and droppings of birds damage the trees, and coconut is of commercial value, villagers prevent the birds from nesting on them. Noise pollution has also increased due to tractors, trains, motor launches and other vehicular traffic. Pesticides are being used widely on paddy crop.

The decrease in the bird population where pesticides are used is long suspected. DDT. in the diet of domestic fowls reduces the egg production, hatchability and sperm production (Rubin *et al.* 1947, Thomas 1962). The mortality among adult and young robins has been proved to be due to DDT. (Twiest 1965, Wurster *et al.* 1965). However, in India, no studies seem to have been done on wild birds on these lines. In August 1976, I found two Cattle egrets in breeding plumage, lying dead in paddy fields about half a kilometer apart near Kaikalur, Krishna District. They were examined for possible marks of injury or gunshots, none were seen.

Even though no direct evidence is available to incriminate pesticides for the disappearance of the pelicans, in view of the large scale deaths reported by villagers, the possibility of pesticides being a major contributory factor cannot be ruled out. Another important factor for the total disappearance of these pelicanries must have been the shortage of food created by human interference. The Kolleru lake is reduced to large canals and fishing is a major industry. Man's competition, perhaps, left no other alternative to these spectacular birds except to give up their traditional home.

Both Neelakantan and Gee had expressed the fear that if Kolleru is drained out for irrigation, the reduced fish supply would endanger the pelicanries. This has happened, and

one wonders where the new home of pelicans is?

Gee had hoped that the new reservoirs formed by hydro-electric and irrigation projects in India may provide new homes for these birds. Can such reservoirs really serve the purpose, unless they are made suitable for breeding colonies of birds? Proper nesting trees, feeling of safety and abundant food supply are necessary prerequisites for the breeding of birds. Fish being the sole food of pelicans its supply must be really large to meet the needs of adult and young birds. The amount of fish required can be estimated from the figures of "Kolleru pelicanries". Gee had counted over 1,500 nests of Grey pelicans. This means 3,000 adult pelicans were in the area at least for a period of 5 months to complete the breeding. On an average a single pelican is estimated to consume 2 kg of fish per day (Ali and Ripley 1968). So 2 kg x 3,000 birds × 150 days = 9,00,000 kg of fish would be required for the adults alone. Add to this the requirement of the young ones. This, of course, was the requirement for the largest pelicanry which only Kolleru lake could have provided as there is no other similar lake on the East Coast. In the absence of any other large lake in the area, the pelicans might have dispersed into smaller breeding colonies.

The most recent report I have seen on the breeding haunt of Grey pelicans is that of the pelicanry at Bellur and Bennali, Mandya District, Karnataka (Neginhal 1976). However, the strength and the antiquity of this pelicanry is not known. If this pelicanry has come into existence only in the recent past, then it is possible that some of the Kolleru birds are nesting here.

The intriguing question is whether these thousands of pelicans disappeared all of a sudden as stated by a villager, or did the pelicanries diminish gradually? The latter seems to be more probable. If so, why could we not save them? In the developing countries, in the name of progress, human needs take precedence over everything else. But what is progress? As Darling and Darling (1963) say "It certainly is not an anthill existence where total human mass is all that matters".

Disappearance of a pelicanry is not a unique phenomenon of Kolleru. The immense pelicanry near Shwe-gyen on the Sittang river in Burma—20 miles long and 5 miles broad, containing millions of pelicans—also disappeared (Smythies—quoted by Gee). The thought crosses my mind that if pelicans get driven from place to place due to shortage of food, paucity of nesting trees, human interference, pesticide pollution and their own overcrowding then will this species, over the years, change its habits or become extinct?

ACKNOWLEDGEMENTS

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S. N. GUTTIKAR

VIRUS RESEARCH CENTRE,
PUNE 411 001,
July 11, 1977.

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9. BREEDING OF THE MALLARD (*ANSER PLATYRHYNCHOS*) IN NEPAL

The HANDBOOK Vol. I, p. 162 states that a large proportion of the Mallard visiting the subcontinent in the winter come from Siberia. This duck also (now) breeds in "very small numbers" on the Kashmir lakes. In the Birds of Nepal (1976) the Flemings write (p. 38) "Thought to nest on Titi Lake (South of the Nilgiri peaks of Annapurna)".

In May/June 1977 I was able to confirm this conjecture with actual sight records.

The Titi lake is situated in north central Nepal (28° 38′ N, 83° 37′ E) at a height of 2622 metres (8600 feet) in a bend on the east side of the Kaligandaki, about $2\frac{1}{2}$ Km. from that river. At its nearest point the Chinese Tibetan border is 45 Km. away. The situation is spectacular with the main peak of Dhaulagiri (8169 m) towering above the lake to the north west. The lake is quite small, very roughly 300 metres long by 200 broad, mostly thickly covered with grass and water plants: less than half consists of clear water, indeed just a "duck pond".

I first visited Titi from 30 April to 2 May 1977. At this time of the year the main spring migration from the subcontinent to the north has passed over the Himalayas, although some stragglers may remain until the end of May. There were five Mallard on the lake, one pair and three apparently unattached males. It was not unreasonable to speculate that three females might be sitting in the thick cover, but we caught no sight of them over the three days. The local people assured us that numerous Mallard did indeed nest and breed there. (Also that they did not molest the birds—apparently, and fortunately for the Mallard, the shooting of one some years ago had been followed within hours by a hail storm which caused considerable devastation!)

Roughly 6 weeks later, from 11 to 13 June, I sent one of my Nepalese boys to look at the lake again. This young man had been with me in May, and on other expeditions into the mountains. He has worked on our farm in Pokhara, where we breed Mallard. I consi-

der his testimony completely reliable. On this visit he counted eleven females and seven males. As far as he could estimate, there were twenty five ducklings about 2 weeks old, the property of three or four mothers. Each evening the drakes flighted to the nearby Kaligandaki river, returning in the very early morning. All the females were visible most of the day, indicating that nesting was over, but not precluding the possibility of some additional females sitting unseen in the thick cover.

It is fascinating to speculate, with other known breeding places 1000 Km to the north west and 2-3000 km to north, how this population of breeding Mallard became, apparently, fully established on such a small lake. Admittedly Titi does lie immediately on a known (but probably not major) migration route along the line of the Kaligandaki river. Considering that the lake lies just two hours off a main trade route, it is not impossible that an examination of other small lakes in remoter areas might yield interesting results. Rare at 2987 m in N.W. Nepal, the largest lake in Nepal, is an obvious candidate for investigation at the correct time of year, but it lacks cover for nesting. This might be established and it would be an interesting experiment, in this National Park, to discover if duck could be induced to breed there by the introduction of natural food and cover plants.

It would also be interesting to learn the true extent of the "very small numbers" breeding in Kashmir, why the numbers have declined, and whether anything can be done to increase them.

In addition to the Mallard, we can record this year the first (apparently) properly authenticated sight record of the Ruddy Shelduck (*Tadorna ferruginea*) breeding in Nepal, indeed in the subcontinent outside Ladakh. The HANDBOOK mentions the Everest region as a strong possibility and the Flemings, the Manangbhot Valley.

Almost certainly the "Brahminy" breeds in both these localities, but our sight record is by Mr. H. S. Nepali (Kaji) of Kathmandu who saw ducklings near the source of the Kaligandaki, about 6 km from the Tibetan border, in June 1977.

Apart from the strictly resident species, the only other normally migratory duck known to nest south of Ladakh and Tibet seem to be the Marbled Teal (in Pakistan) and White-eyed Pochard (in Kashmir). The discovery of the Mallard nesting far to the south of its former limits prompts the question whether a good food supply and congenial surroundings may be more important than longer hours of daylight. However, the Mallard is probably the most adaptable of all ducks.

MOUNTAIN TRAVEL,
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July 20, 1977.

JAMES O. M. ROBERTS

10. OCCURRENCE OF REDHEADED MERLIN, (*FALCO CHICQUERA* DAUDIN) IN BANGALORE, KARNATAKA

The distribution of Redheaded Merlin in S. India as given by Sálim Ali & Ripley (1968) shows that this bird has not been recorded from Karnataka. There is a definite record of this bird from Cudappah (Koelz 1947). in 1960, Neelakantan recorded this bird from Kerala. On 28th June, 1975, a pair of this bird was sighted just on the outskirts of Bangalore. As the distribution of this bird is still not clear, this record may be of interest.

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PUNJAB AGRICULTURAL UNIVERSITY,
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P. M. GOVINDAKRISHNAN

DEPARTMENT OF ENTOMOLOGY,
UNIVERSITY OF AGRICULTURAL SCIENCES,
BANGALORE 560 024,
July 16, 1977.

ABRAHAM VERGHESE
A. K. CHAKRAVARTHY

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11. ORANGERUMPED HONEYGUIDE (*INDICATOR XANTHONOTUS*) IN THE GARHWAL HIMALAYAS

Blyth, describing *Indicator xanthonotus* in 1842, regarded it as rare and sporadically occurring in the Himalayas. Hume in 1870 described a new subspecies *I. x. radcliffi* based on a single specimen obtained from Hazara in the western Himalayas. Recently Ripley (1951) described a third subspecies *fulvus* from the eastern Naga Hills in Assam.

It is intriguing to note that this species was either overlooked or not particularly looked for by later ornithologists who did extensive study of the avifauna of certain portions of the Himalayas. Perhaps the lack of information has led to the belief that the species is exceedingly rare in the subcontinent.

In 1973 Drs Sálim Ali, Ripley and myself spotted quite a number of these birds in certain areas in central Bhutan, where I subsequently carried out some detailed study of their habits (in press). In the meantime Cronin and Sherman (1977) have reported on certain aspects of the behaviour of the species they studied in eastern Nepal.

Recently while on a nature trek with Society's members to the Valley of Flowers in the Garhwal Himalayas, I spotted Honeguides

feeding on bee-wax near Gangharia village *c*. 9000 ft, on the Govindghat—Valley of Flowers bridle path, on 23 July 1978. Four active beehives and several old broken combs were situated on an overhang of a rocky slope close to the bridle path. Three birds were noted frequenting the site of feed on that occasion. On subsequent observations I could spot the territorial male from other birds that frequently visited to feed on the wax. From the behaviour of the birds it was apparent that the breeding season was still on. The habitat around the site consists mainly of stands of Deodar (*Cedrus deodara*), *Rhododendron* sp., and *Quercus* sp.

According to available literature the population in this part of the Himalayas is *radcliffi*. However, this subspecies is described from a single specimen and since the first description no specimen has been collected. Sálim Ali & Ripley (1970) mention Hugh Whistler seeing this bird on 24 April 1923 at Truin, Dharmasala, *c*. 2900 m and consider it as the last authentic record. Friedmann (1974) mentions Walter Koelz's collection in 1940's of several specimens of Honeyguides from Garhwal (exact localily not specified). Koelz noticed them feeding on exposed bee combs and several of the birds collected had beeswax in their gizzards.

The evidence gathered recently indicates that this species is not so rare as it is made out to be and therefore it should be possible to obtain more data of biology and ecology of this unique bird.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
BOMBAY 400 023,
August 25, 1978.

S. A. HUSSAIN

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12. SOME OBSERVATIONS ON THE WARBLER (AVES: SYLVINAE) POPULATIONS OF THE UPLAND PERENNIAL WETLANDS IN THE EASTERN GHATS

There is an extensive perennially wet area (at least 300 sq miles) mainly in the Paderu taluk (*c*. 17°57′N, 82°40′E), Vishakapatnam district, Andhra Pradesh. The area is at about 3500 ft m.s.l. with hills rising up to 5000 ft. The habitat consists of (1) Paddy fields (two crops per year), (2) several acres of mature forest around each village, (3) regenerating scrub and woodland along the hillsides where shifting cultivation is practised, (4) grassy hill tops.

This area has not been ornithologically sur-

veyed before and there are several species of birds, e.g. a partridge, quail and red Munia (*Estrida amandava*) which are not found at lower, drier altitudes, the ghats (i.e. on the Chintapalle plateau) (Price, *in prep.*). Some species are held in common with the coastal plains while others are confined to this area. Particular attention was paid to the Warblers (Sylviinae) and here I detail the complete list noted in two visits to Locheli, about 15 miles south of Paderu on 6th May and 25 June 1977. Unfortunately adverse weather conditions prevented successful trapping of the birds.

INDIAN PALEFOOTED BUSH WARBLER (*Cettia pallidipes*):

Known previously in the Eastern Ghats from only one specimen (Whistler & Kinnear 1933), this bird is extremely common in the better wooded areas. Males were in song on both occasions, more so in May. Birds were twice heard along water courses on the Chintapalle plateau, both near to the Paderu plateau and it is likely that they had spread from there.

STREAKED FANTAIL WARBLER (*Cisticola juncidis*)

Abundant on the paddy fields.

FRANKLIN'S WREN WARBLER (*Prinia hodgsonii*)

Uncommon in the thicker more advanced regenerating growth.

PLAIN WREN WARBLER (*Prinia subflava*)

Found around the periphery of the paddy-fields. This species and *C. juncidis* are the common resident warblers of the coastal plain. During my only visit to the plains, both species were noted near Vizianagram on 2nd August 1977. They were much less common than at Lacheli, possibly because the area is not under wet cultivation throughout the year. *P. subflava* was not seen on the Chintapalle plateau. *C. juncidis* was recorded occasionally and probably breeds in very low numbers.

JUNGLE WREN WARBLER (*Prinia sylvatica*)

Common on the drier slopes right up to the hill tops. The territories of this and *P. subflava* abut (with no overlap) possibly reflecting the abrupt change from wet areas to those on the slopes that are well drained and with poor soil. They are extremely difficult to separate by plumage although *P. subflava* is notably smaller. All birds were in song and this was the best identification character.

TAILOR BIRD (*Orthotomus sutorius*)

A few pairs around every village. This bird, *P. hodgsonii* and *P. sylvatica* are all represented on the Chintapalle plateau (e.g. at Lamasinghi, Price, *in prep.*) in similar habitat to that at Locheli. This means that *P. sylvatica* is less common and the other two species more common at Lamasinghi. The Ashy Wren Warbler (*Prinia socialis*) is the commonest wren warbler at Lamasinghi and although a few pairs extend up to the Paderu plateau, it is totally absent at Locheli. This presumably reflects the absence of sufficient lush regenerating growth as is found on the Chintapalle plateau.

BROADTAILED GRASS WARBLER (*Schoenicola platyura*)

A pair seen near the village of Chinagada (26 June 1977) in and around thick grass and bush cover above a paddy field. Apart from one specimen, probably a straggler, at Point Calimere, Tamil Nadu (Hussain 1977), this species was only previously known from the southern Western Ghats (Ali & Ripley 1973). The male was watched for over half-an-hour, constantly repeating a five to ten second song, mostly in display flight but also from perch. Description taken at the time: Upper parts uniform warm brown. Under parts white,

throat conspicuous against the ochraceous breast. Tail darker underneath, strongly graduated, finely cross rayed. Bill and eye black. Song: a twittering almost goldfinch-like, ending with a tit like call. Also 'pinks' from a perch at times. The birds were breeding but no nest could be found. I later examined the specimens in the Bombay Natural History Society collection and am convinced of its identification.

During this survey I was supported by a grant from the Leverhulme Trust Fund and sponsored by the Bombay Natural History Society.

TREVOR PRICE

DEPT. OF ECOLOGY AND EVOLUTION,
UNIVERSITY OF MICHIGAN, U.S.A.,
August 12, 1977.

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13. FAECAL FEEDING IN THE WHITEHEADED BABBLER, *TURDOIDES AFFINIS* (JERDON)—A REJOINDER

This is to draw attention to Mr. D. E. J. Jeyasingh's note in Vol. 73, No. 1 of the *Journal* (page 218) on the above subject.

Mr. Jeyasingh writes on the Whiteheaded Babbler swallowing the faecal sacs of its young and questions the normally held view that this involves nest sanitation. He suggests "an alternate line of reasoning". According to him, the faecal sac has some nutritional value for the parents.

Without getting into any controversy on the subject, I would like to place on record my own observations. I have had occasion to watch several species of birds at close quarters while photographing them on their nests. A pity it never occurred to me to keep records of the number of times a parent bird swallowed the faecal sacs and the number of times it carried them away. The impression I have gained, however, is that while some birds do swallow the packets, the majority carry them away.

Redvented Bulbuls tended to swallow the sacs particularly when the chicks were newly hatched as also did the Yelloweyed Babblers watched by me. My impression is that this was in response to the parents not wanting to leave the newly hatched young exposed and as the chicks grew a little larger, the sacs were carried away. Marshal's Ioras, Small Minivets, Whitebellied Minivets, Jungle Wren-Warblers, Rufousfronted Wren-Warblers, Franklin's Wren-Warblers, Tailorbirds and Purple Sunbirds were not seen to swallow the packets. The faecal packet was invariably carried away by Indian Robins and Rufouswinged Bush Larks.

It is interesting to note that while the cocks

of the Minivets and Sunbirds helped in feeding the chicks, and even fed the hen while she incubated the eggs, they never incubated them. On the other hand, the Ioras shared incubation. Among the Wren-Warblers, I suspect, incubation is largely by the female as is true for the Tailorbird and quite definitely for the Indian Robin.

My observations tend to suggest that nest-building is largely, if not exclusively, done by the hen in case of the Iora, the two species of the Minivets, the Tailorbird, and certainly in the Purple Sunbird and the Redvented Bulbul, but in all cases the dutiful husband either followed the wife around or sang prominently from an exposed perch nearby. I found this also in the case of a pair of Blackheaded Orioles in Borivli National Park near Bombay. It was the continual display and melodious calls of the cock which drew my attention to the nest tree and the nest. Throughout the two hours S. R. Nayak and I watched the pair, the male did nothing to help in nest building. It was here that I was able to point out to Nayak and Humayun Abdulali the very distinct colour difference between the sexes, the cock was an appreciably richer golden orange. Subsequent examination of specimens in the Society's collection by Mr. Abdulali and myself confirmed the distinct colour variation.

Members may find interesting K. K. Neelakantan's note on a pair of nesting Tailorbirds immediately following Jayasingh's note. Neelakantan's observations substantiate my opinion.

LAVKUMAR KHACHER

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Great Western Building,
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February 25, 1977.

14. OCCURRENCE OF THE THICKBILLED WARBLER *PHRAGMATICOLA AEDON RUFESCENS* STEGMANN AT BAJ BAJ, WEST BENGAL

While working out a collection of birds from lower Bengal, I came across two specimens of the Thickbilled Warbler, of which one belongs to the nominate *Phragmaticola aedon,* while the other appears to represent the Amurland subspecies, *Phragmaticola aedon rufescens* Stegmann. It differs from the nominate *aedon* in being darker and more saturated with rufous above and the lacking the olive wash. The centre of the breast, the sides of the abdomen, flanks and the under tail coverts are rich fulvous.

Phragmaticola aedon aedon (Pallas)

1 ♀; Baj Baj, 24 Parganas District, W. Bengal; February 15, 1977; S. Chattopadhyay collector.

Measurements: Wing 79, tail 82.5, bill 20.5, tarsus 26.7 mm.

Phragmaticola aedon rufescens Stegmann

1 ♂ Baj Baj, 24 Parganas District, W. Bengal; December 20, 1975; S. Chattopadhyay collector.

Measurements: Wing 78, tail 82, bill 20.5, tarsus 24.5 mm.

This report extends the range of this subspecies and is the first authentic record of its occurrence in the Indian territory. Dr. Salim Ali has, however, kindly informed me verbally about its occurrence in Kutch on the basis of a specimen caught by him in a mist net.

My specimens of *rufescens* was observed in an open grass field near a patch of water covered by pith plant (*Aeschynomene indica*), while the nominate *aedon*, a common winter visitor to this area, affects a different ecological niche, that is, water hyacinth (*Eichhornia crassipes*) covered channels and marshes covered with reeds and bushes.

A harsh *check-check-checkrrsh* note was produced by the bird from the perch.

BAJ BAJ, WEST BENGAL,
July 6, 1977.

SRIKUMAR CHATTOPADHYAY

15. ON THE OCCURRENCE OF THE BURMESE BLACKBROWED FLYCATCHER WARBLER. *SEICERCUS BURKII TEPHROCEPHALUS* (ANDERSON) AT BAJ BAJ, WEST BENGAL

According to the extant literature, of the five recognized subspecies of the Blackbrowed Flycatcher-Warbler only two, namely, *Seicercus burkii burkii* (Burton) and *Seicercus burkii whistleri* Ticehurst has been known to occur in the Indian territory. While working out a collection of birds from lower Bengal, I came across two specimens of the Burmese Flycatcher-Warbler, *Seicercus burkii tephrocephalus* (Anderson). They differ from the nominate *burkii* in being darker green, with distinct coronal bands, central band ashy (mixed with olive) and lateral bands darker.

The Burmese Flycatcher-Warbler has been known to occur in Burma (Chin hills to Shan States), east to northern Yunan (Likiang range) and south Sikang in China. It winters in northern Thailand. Beyond those areas non-breeding birds were taken from Bangladesh [Sundarbans (Burigolani) and Chittagong Hill tracts (Rangamati and near Manimukh)] in February, March and April. Therefore, this record extends its range further westward in the Indian territory.

Material: 1♂, 1♀ (15, 20 Feb. 1977), Baj Baj, West Bengal. Srikumar Chattopadhyay, Collector.

Measurements:

	Wing	Bill	Tail	Tarsus
♂	56	14	43.7	20 mm
♀	53	13.9	43	20 mm

The specimens were collected while the birds were foraging in mixed feeding parties of other warblers in a bamboo grove. This little bird was observed flickering its tail in order to display its white patch at the base, while producing a sweet whistling note. It was also observed that the bird prefers core of bamboo thickets at a height of *c* 5 m from ground level.

BAJ BAJ, WEST BENGAL,
July 4, 1977.

SRIKUMAR CHATTOPADHYAY

16. OCCURRENCE OF THE BLUEHEADED ROCK THRUSH, *MONTICOLA CINCLORHYNCHUS* (VIGORS) (MUSCICAPIDAE: TURDINAE) IN ORISSA

During the course of avifaunal survey in February-March, 1977, in Orissa, an interesting specimen of the Blueheaded Rock Thrush *Monticola cinclorhynchus* (Vigors, 1832) was collected from the Govindapalle, Koraput District, Orissa on February 29.

The specimen is a male which measures: Wing 105, bill from the skull 24, tail 72, tarsus 25 mm. and its weight is 34 g. According to standard literature on Indian ornithology like Baker (1924), and Ali and Ripley (1973), in summer this species is known to breed in the Himalayas from western part of Pakistan through Kashmir as far east as Arunachal Pradesh thence south to Nagaland. It is also found in Cachar (Assam), Khasi and Garo hills (Meghalaya) where it breeds. In winter it migrates mostly to the Western Ghats from Gujarat, south through Maharashtra, Karnataka, Kerala and Western Tamil Nadu, and has also been recorded from Madhya Pradesh, Uttar Pradesh and Rajasthan, Sikkim, Assam and in Pakistan. So far it has not been known from Orissa. The present example, therefore, serves as the first record of its occurrence in Orissa.

ZOOLOGICAL SURVEY OF INDIA,
INDIAN MUSEUM,
CALCUTTA 700 016,
May 7, 1977.

N. MAJUMDAR

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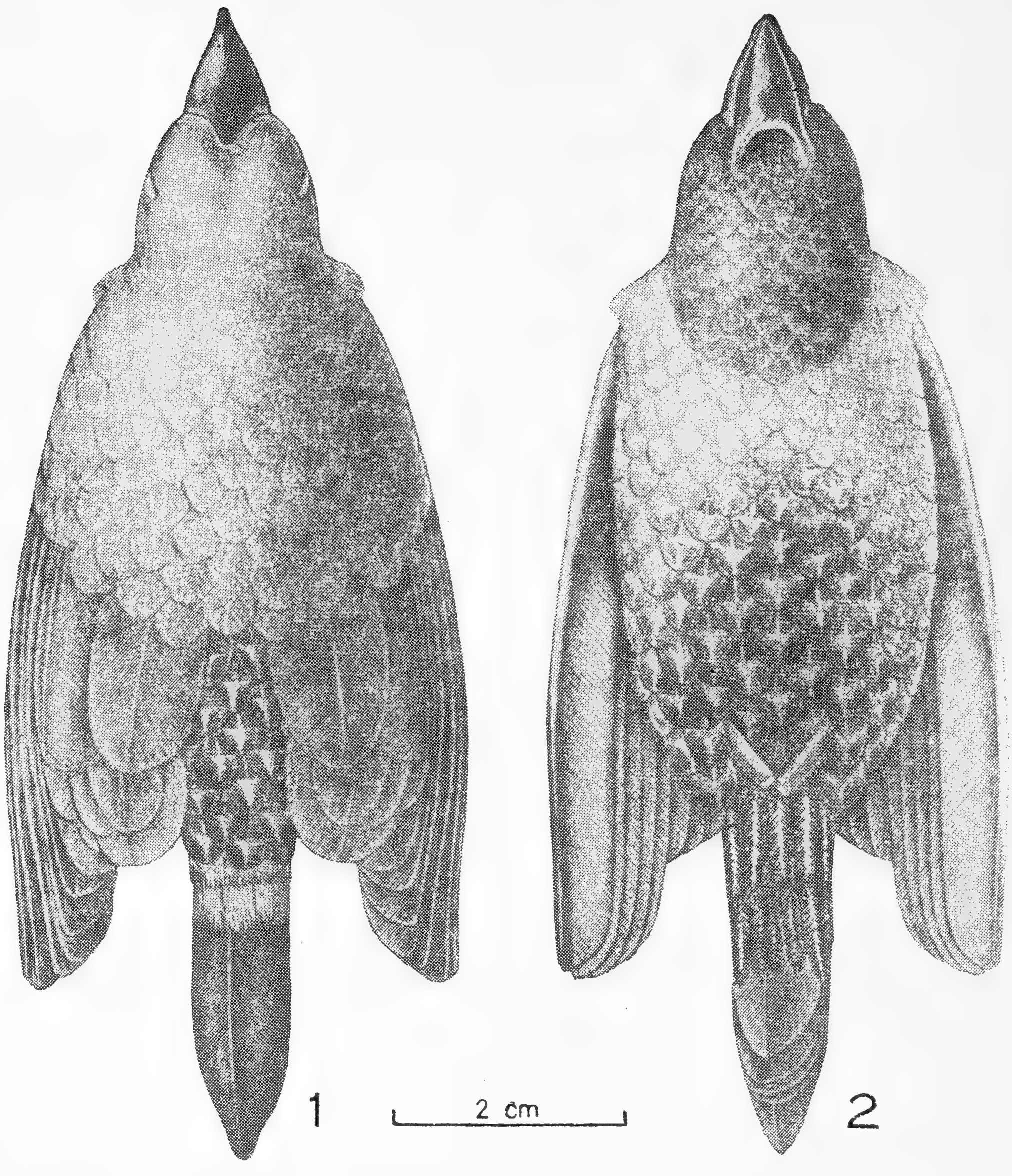
17. ON THE TAXONOMIC STATUS OF THE EASTERN GHATS RUFOUSBELLIED MUNIA, *LONCHURA KELAARTI VERNAYI* (WHISTLER AND KINNEAR, 1933) [AVES: PLOCEIDAE]

(*With two text-figures*)

The Eastern Ghats population of the Rufousbellied Munia was separated from *Lonchura kelaarti jerdoni* (Hume) 1875 as *L. k. vernayi* by Whistler & Kinnear (1933), with Sankrametta (Vishakhapatnam District, Andhra Pradesh) as the type-locality. Ali & Ripley (1974, p. 111), however, treated *vernayi* as a synonym of *jerdoni* because the former was 'Described from three specimens of *jerdoni* in immature plumage' (loc. cit., note).

However, while working on recent collections of birds from Orissa made by this Department, I find that the specimens of this species from Kotagarh, Phulbani District,



Figs. 1 & 2. *Lonchura kelaarti vernayi* (Whistler & Kinnear)
1 Dorsal view. 2. Ventral view.

Orissa (at the northern region of the Eastern Ghats), do not agree with the description of *jerdoni* as given by Baker (1926) and Ali & Ripley (1974). The differences between the populations from Orissa (on the basis of 2 ♂, 1 ♀ and 1 juv. ♀) and southwestern India (on the basis of published descriptions, Whistler & Kinnear, 1933; Ali & Ripley, 1974) may be tabulated as under:

	Orissa population (Eastern Ghats)	South Western Indian Population
Above :		
Forehead :	Dark chocolate brown up to middle of head.	Dark chocolate brown.
Rump :	With several conspicuous cruciform pinkish white markings (Fig. 1).	Dark chocolate brown.
Upper tail-coverts :	Light yellowish brown.	Glistening rufous.
Below :		
Breast and upper abdomen :	Pinkish buff·	Pinkish brown.
Lower abdomen :	Pearly pink, cruciform markings occupy the whole length of abdomen (Fig. 2).	Pinkish brown. Dark fulvous with pinkish wash. Cruciform markings confined to a small area on the vent.

Measurements :		Wing	Bill	Tail		Wing	Bill	Tail
	2♂	55,57	13	40	♂	56-59	13-14	37-43
	1♀	57	13	40	♀	57-59	–	36-39

It would, therefore, appear that *Lonchura kelaarti vernayi* (Whistler & Kinnear, 1933) should be resuscitated for the Eastern Ghats population.

Regarding the date of publication of Hume, it should be taken as 1875 in view of the postcript which was dated 31st December 1874 by the author.

Incidentally this species is a new record from Orissa.

I am grateful to Drs. B. Biswas and A. K. Mukherjee, Zoological Survey of India, Calcutta for their valuable suggestion and for going through the manuscript.

Zoological Survey of India,
Indian Museum,
Calcutta 700 016,
May 7, 1977.

N. MAJUMDAR

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18. PERMANENT MARKING SYSTEMS FOR CROCODILIANS

Introduction

Captive breeding and wild management of crocodilians necessitates establishing marking systems which are simple, permanent and conspicuous. The use of monel metal number tags (cattle tags such as are used in sea turtle tagging programs) clipped in the web of crocodile hind feet may be a useful semi-permanent marking system. The main drawbacks are that the animal must be captured for close examination of the tag and that the webbing may tear.

The Madras Crocodile Bank has a population of about 150 crocodilians. Many of these will be released through the State Forest Department and the remainder are retained as breeding stock. We are interested that correct sex ratios are maintained for release and captive breeding and that the breeding stock will continue receiving new genetic material.

Methods

Caudal Clipping: Our main marking system is the clip method. By clipping the protruding double (DCW) and single (SCW) caudal whorls (the pointed dorsal tail scutes) at the base, one achieves a simple permanent identification mark. Hatchling and yearling crocodiles may have to be clipped again at 2 or 3 years as the scutes grow back partially. We use ordinary clean surgical scissors for clipping smaller animals and a good pair of garden clippers are suitable for clipping larger animals. Considering that 12 DCWS and 5 SCWS (tailtips are frequently lost) are available for permanent marking, there are over 100 combinations.

The crocodile is securely held and the DCW or SCW quickly and firmly cut off at its thick base. The wound bleeds slightly (antiseptic may be applied) and heals quickly. We clip every female on the first left DCW and use other clippings for age and genetic coding (i.e. 1st right DCW is a 1977 hatching, 1st SCW signifies origin is Tamil Nadu.

Branding: In the U.S. where biologists are working with large alligator populations, branding the lateral surfaces of the caudal scutes is used for permanent conspicuous marking (C. A. Ross, pers. Comm. 1977). A portable 6 or 12V battery operated soldering iron is used in the field and 110V wall plug soldering iron for captive conditions. The hot tip is gently touched for a moment on the desired spot resulting in a dark spot brand. The crocodile apparently suffers only momentary discomfort and the possible combinations are almost infinite. In the case of crocodilians like the *C. palustris* and *Gavialis gangeticus* inhabiting open river areas branding and clipping may prove to be suitable for distant visual identification of specific animals using binoculars or spotting scopes.

R. WHITAKER

Madras Crocodile Bank Trust,
Madras,
February 23, 1978.

19. NOTES ON *PHELSUMA ANDAMANENSE*, THE ANDAMAN DAY GECKO OR GREEN GECKO

(*With a photograph*)

In April 1975, when Z. W. made the first Madras Snake Park Trust herpetological expedition to the Andaman Islands, she noted the relative abundance of the gecko *Phelsuma andamanense* particularly in gardens containing smooth palms (coconut, arecanut and others) and plantain trees. Secondary preferences were peepal, papaya and occasionally exotic avenue trees (in Mayabandar). R.W. on a visit in June 1977 saw a few *Phelsuma* on streamside jungle trees and one on a vine at Burmah Nullah, South Andaman. This was the only jungle sighting of *Phelsuma* in three months in the field. R.W. found *Phelsuma* in Diglipur, North Andaman, again only around human habitation (on a wooden porch at the Diglipur Ranger's residence). It was found to be common in the Mayabandar area and the populations of a coconut grove near Webe village on the Mayabandar-Rangat road were easily observable. Several days were spent observing these active reptiles.

29/vi/77: Temperature at 6 a.m. 25°C; at 5 p.m. 28°C; sunny morning, rain most of the afternoon. 10 *Phelsuma* were visible in the early sun, most on the coconut palm branches at the wide base, several others seen on the flowers of the palm. Those observed included adult males, females, what appeared to be half grown juveniles and small juveniles, recently hatched. One tree was picked out and the *Phelsuma* population observed with 7 × 50 binoculars whenever there was free time. The following are a few observations made from field notes:

5/vii/77: Adult female and half grown juvenile on blooming coconut flower. Avoid bees of several kinds and snap up certain flies. One tailless small juvenile emerged onto another flower. They walk in typical gecko fashion with occasional sudden jumps. Very agile. Adult female moved to underside of frond and was approached by tail waving adult male. Adult male covered half of adult female's body before adult female suddenly darted forward, tail waving. After a short time she turned, returned to adult male and touched him on the side. Adult male turned and crawled up the stem and adult female resumed basking. This tree appears to have 6 resident *Phelsuma* as two more half grown juveniles (appearing to be almost mature females about 11 cm) were seen later.

7/vii/77: Morning watched *Phelsuma* on coconut palm 6 m up, mainly on flowers; one adult male, 2 adult females and 3 half grown juveniles all feeding at flowers. Not only awaiting insects but licking stems and flowers (possibly sweet sap or condensed moisture). Watched half grown juveniles stalk and capture small blue butterfly, black ant, and 2 species of small bees or flies, all attracted to the coconut flower. Adult male actively chases small juveniles and half grown juveniles away. He jumps at adult females but they only dodge and generally return. Considerable tail wagging indulged in by all *Phelsuma* particularly during close approaches of another. Adult female after dodging adult male, turns and raises head, exposing yellow throat and flexes front legs and forebody. Adult male, when threatening juveniles and rival males, raises up (straightens) front legs and turns body toward the other to display red spots at tail base and

top of head.

In dominant males (upto 14 cm) head, tail-base and tail are bluish grey. Females are generally brilliant green (as is the adult male's dorsal body colour), juveniles are generally a darker green. When captured *Phelsuma* turn brownish black. The red spots fade but re-appear, beautifully superimposed over the dark velvety pigment. After release in the sun light the green gradually returns in ragged patches. The underside is either yellow, light green or bluish grey.

Judging from the size of most of the small juveniles, the main hatching season is in the early monsoon (May). However, hatchling size *Phelsuma* are seen in July and Jerry Vaughan, a resident of the islands observed mating this year on 24th July.

M. A. Smith (1935), gives a good general description of this delightful lizard and writes under Range: "The Andaman Islands, where it is common particularly in the vicinity of Port Blair; of diurnal and arboreal habits, but found also sometimes in houses. Stoliczka (1873) states that it generally hides under the bark of trees but also often feeds on the ground".

Its greater density in the dwelling areas in and around Port Blair and Mayabandar may be due to the preponderancy of optinum habitat trees, i.e. coconut, arecanut, plantain in open sunny groves which seem to be the pre-

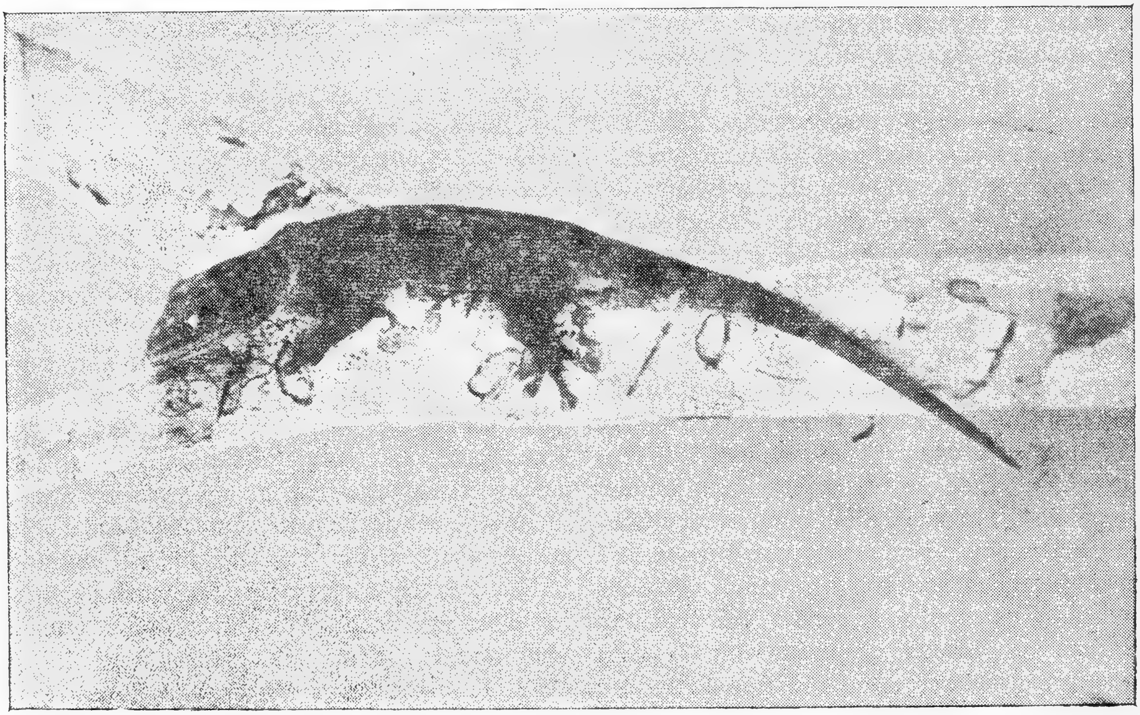

Fig. 1. Adult female Andaman Day Gecko.

ference of this species. A visit to the Port Blair zoo (run by the Forest Department) was doubly interesting; besides seeing caged endemics like the Narcondam Hornbill and Nicobar Megapode we spent a good time watching *Phelsuma* antics in the zoo grounds.

Annandale (1904), wrote that "*P. andamanense* is probably the most interesting of the Andaman lizards. Its allies are found not in the Malayan islands or on the mainland of Asia, nor even on the mainland of Africa, but in Mauritius, the Seychelles, Reunion and Madagascar."

No further work has been done on *Phelsuma*; its call remains undescribed and we know next to nothing of its biology. Meanwhile it remains unlisted on the Wildlife Act Schedule (besides several other Andaman endemics) and deserves to be protected as a national monument as being a uniquely Indian species, found no where else in the world.

MADRAS SNAKE PARK TRUST,
MADRAS 600 022,
February 14, 1978.

R. WHITAKER
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20. BREEDING OF TOKAY GECKO

(*With a photograph*)

In the two most recent definitive works on S. E. Asian herpetology, Smith's FAUNA OF BRITISH INDIA Vol. 2 and Taylor's LIZARDS OF THAILAND there are only a few facts on the breeding biology of *Gecko gecko*. Smith has nothing and Taylor mentions the colour of the young and describes the eggs: "The biscuit-shaped eggs are plastered together and against a surface, usually in some dark place and left to hatch. Each female lays only two hard shelled eggs at a single laying."

Two pairs of this giant gecko were received at the Madras Snake Park from Calcutta during 1976. They are housed in a well ventilated, glass fronted display terrarium. Their average length is 25 cm.

On 6 July the keeper, M. Mani, discovered 2 eggs adhering to a small dry log kept in the terrarium. They were a few cms apart and measured about 6 cm in diameter. One of the eggs was accidentally knocked off. The remaining egg hatched on September 8th, an incubation period of 64 days.

The hatchling is 9 cms in length and brilliantly marked, dorsal reddish brown with white spots, underside greyish brown, with a black and white banded tail. It is a most lively young gecko, chirping and jumping, open mouthed if a finger is poked too close. Already it shows the adult tendency of biting and refusing to let go.

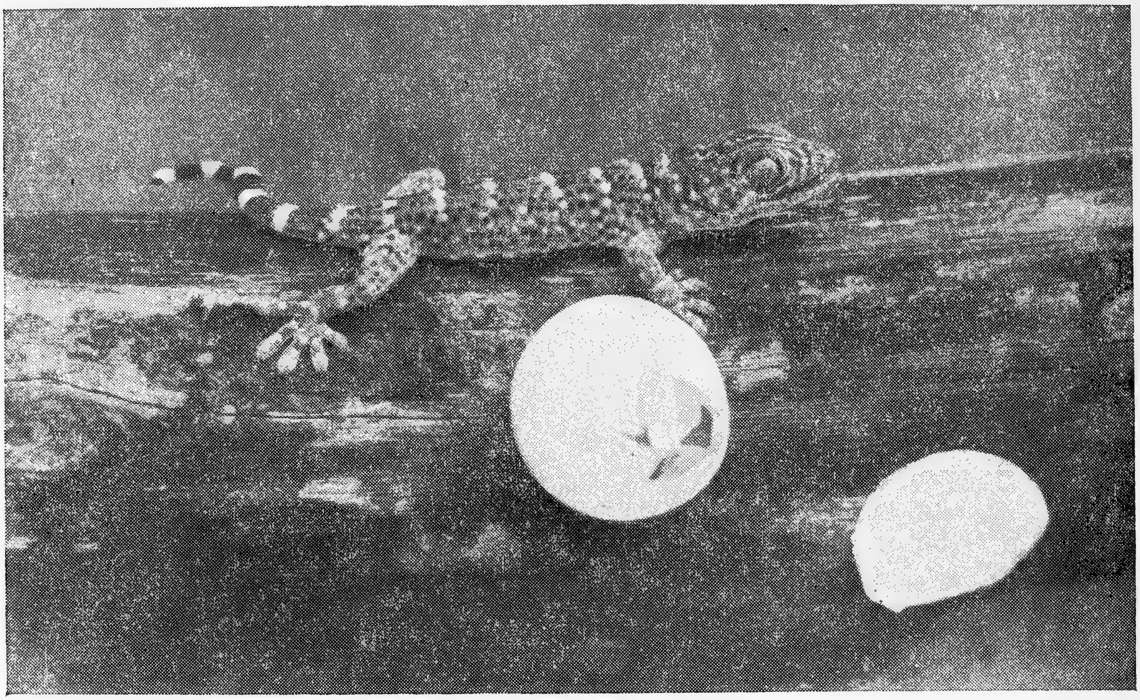

Fig. 1. Tokey Gecko hatchling showing empty egg adhering to branch.

MADRAS SNAKE PARK TRUST,
MADRAS-600 022,
October 19, 1977.

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21. RANGE EXTENSION FOR THE SNAKEHEAD *OPHIOCEPHALUS GACHUA* HAMILTON-BUCHANAN (OSTEICHTHYES: CHANNIDAE) IN IRAN

The snakeheads are freshwater fishes of tropical Africa and southern Asia with an interrupted distribution being absent from Iran and the Arabian Peninsula according to Nelson (1976). However one species, *Ophiocephalus gachua,* has been recorded from Iran in the upper or middle reaches of the Bampur River, Baluchistan (Nikolsky 1899). In addition a single specimen has been caught in an irrigation ditch 2 Km. south of Sabzeveran (=Jiroft) in the drainage of the River Haliri, Kerman Province on 6 May 1977 (28° 39′N, 57° 45′E). This locality lies over 300 Km. to the north-west of the Bampur River at Bampur and is the most westerly locality for the genus *Ophiocephalus.*

The specimen is a female, 135 mm total length, with 33 dorsal fin rays, 22 anal fin rays, 16 pectoral fin rays, 5 ventral fin rays, and 43 scales in the lateral line with 4 scales

above and 9 scales below the lateral line. In the live specimen the caudal, dorsal and anal fins were edged with a strong orange colour and the anal fin was light orange. All these fins had an iridescent green colour between the fin rays. In the preserved specimen the orange fin margins become white (cf. Kahsbauer, 1963).

ACKNOWLEDGEMENTS

This research was funded by a Pahlavi University Research Council grant number 35-A5-149-172 which the author gratefully acknowledges.

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22. ON THE OCCURRENCE OF *ICHTHYOPHIS PENINSULARIS* TAYLOR, (GYMNOPHIONA: CAECILIDAE) FROM ALAMCHOLAI (DISTRICT KANYAKUMARI, TAMIL NADU, INDIA)

Genus *Ichthyophis* has a limited distribution, mostly confined to the hilly regions of Western India from Malabar to Bombay, Nilgiris, and foothills of Himalayas.

Daniel (1963), has given an account of the distribution and habit of the Indian Caecilidae. Taylor (1961), described seven species of the genus *Ichthyophis* in India of which the species *peninsularis,* according to him has been recorded only from Malabar. No other record exists of this species elsewhere in India. The present collection, a single specimen was made from Alamcholai, a mountainous region (8°26′ N, 77°15′ 30″ E) located about 65 km north of Cape Comorin near the Tamilnadu-Kerala border in south west India. The specimen collected from underneath a decomposing fallen bark was identified as Taylors' *I. peninsularis.*

Total length 330 mm, head length to body length 20 times, tail length in total length 30 times, body girth in the middle 40 mm, transverse folds 364, folds on tail 18, tentacle closer to eye than to nostril. Anal slit longitudinal. There is a distinct oval white spot around the anus. Dorsal side dark, ventral side very light, cream coloured.

The present record of this species extends its range of distribution farther south from Malabar to Alamcholai in Kanyakumari District of Tamil Nadu in the South Western India.

My thanks are due to Dr. S. V. Job for going through the manuscript and to K. Dharmaraj, C.S.I.R. fellow, Aquarium, Trivandrum, in helping me to identify the specimen.

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January 9, 1978.

P. JAISINGH

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23. INSECTS VISITING LAC INSECT FOR HONEYDEW[1]

The lac insect, *Kerria lacca* (Kerr) excretes honeydew after settling at the suitable site on the shoots of the host plant species and a number of insects are attracted to it. The excretion often accumulates at the anal opening of the lac test, even ferments and attracts the sooty moult to grow thick enough to form a felt like covering over the lac insects killing them by suffocation. Honeydew is believed to be a waste product excreted into the Colo-rectum from the loops of the intestine that are suspended within the Colo-rectum (Kapur 1962). The frequency of excretion of the honeydew per insect per hour varies from 2.08 to 3.30 droplets by the larva and from 8.04 to 10.10 droplets by the fertilised females and it contains seventeen amino acids (Srivastava & Varshney 1966, 1968). A mature female excretes 0.2974 to 1.1716 cu. mm. honeydew per hour (Varshney 1972).

Mahdihassan (1925, 1939) reported several insects associated with lac but did not report any insects associated with honeydew, whereas Negi *et al.* (1930) and Mahdihassan (1957) reported 17 insects, belonging to orders Hymenoptera and Diptera, associated with honeydew but without stating the crops and localities from where they were collected. Attempts were, therefore, made at Regional Field Research Station for lac, Damoh, Madhya Pradesh, to collect insects visiting honeydew during both the *rangeeni* crop seasons namely, *baisakhi* (October/November to June/July) and *katki* (June/July to October/November). A total of 48 insects collected by us, Negi *et al.* (1930) and Mahdihassan (1957), are being presented in table 1. The insects collected by these authors are shown by a + sign and those not collected by a — sign, and have been arranged under the orders and families.

It will be seen from the collections that hymenopterous and dipterous insects were the frequent visitors during both the crop seasons whereas lepidopterous insects were found only during *katki* and hemipterous insects only during *baisakhi* crop seasons. During *katki* crop season, *L. quadrispinous* and *M. brunnea* were found to build their formicaries round the sparse encrustation. Similarly, *D. koenigii* appeared during the time of male emergence during *baisakhi* crop season.

[1] This paper was read at the Seminar on Lac Production held at the Indian Lac Research Institute, Namkum, Ranchi on 9-10 November 1973 and refers to No. C-28 on p. 25 of the abstract.

TABLE 1

INSECTS COLLECTED OF HONEYDEW BY VARIOUS AUTHORS

Species	Collected by the present authors *baisakhi*	*katki*	Negi *et al.* (1930)	Mahdihassan (1957)
Hymenoptera				
FORMICIDAE				
1. *Camponotus angusticollis* Jerd.	+	+	–	–
2. *C. angusticollis* var. *sanguinolentus* For.	–	+	–	–
3. *C. compressus* Fabr.	–	–	+	–
4. *C. rufoglaucus* Jerd.	–	+	–	–
5. *C. serioeus* Fabr.	–	+	+	–
6. *C. variegatus* var. *fuscithorax* Forel.	–	–	+	–
7. *C.* near *varians* Roger	–	–	+	–
8. *Cremastogaster* sp.	+	+	–	–
9. *Dolichoderus* sp.	+	+	–	–
10. *Lophomyrmex quadrispinous* Jerd.	–	+	–	–
11. *Monomorium dichroum* For.	–	+	–	–
12. *M.* near *indicum* Smith	–	–	+	–
13. *M. latinoda* Mayr.	–	+	–	–
14. *Myrmicarica brunnea* Saund.	–	+	–	–
15. *Solenopsis geminata* subsp. *rufa* Jerd.	–	–	+	–
VESPIDAE				
16. *Polistes stigma* Fabr.	–	+	–	–
17. *Vespa orientalis* Fabr.	+	+	–	–
MUTILLIDAE				
18. *Mutilla* sp.	–	+	–	–
SPHEGIDAE				
19. *Sceliphron madraspatnam* Fabr.	+	–	–	–
APIDAE				
20. *Micrapis florea* Fabr.	+	–	–	–
CHALCIDIDAE				
21. *Brachymeria fulvitarsis* Cam.	–	–	–	+
Diptera				
MUSCIDAE				
22. *Musca* sp.	+	+	–	–
23. *Musca ventrosa* Wied.	–	+	–	–
24. *M. pattoni* Aust.	–	+	–	–
25. *M. illingworthi* Patton.	–	+	–	–
26. *Gymnodia tonitrui* Wied.	–	–	–	+
27. *G. tonitrui* ab. *canache* Walk.	–	–	–	+

Species	Collected by the present authors *baisakhi*	Collected by the present authors *katki*	Negi *et al.* (1930)	Mahdihassan (1957)
CALLIPHORIDAE				
28. *Chrysomyia megacephala* Fab.	+	+	–	–
29. *C. rufifacies* Macq.	–	+	–	–
30. *C. albiceps* Wied.	–	–	–	+
TABANIDAE				
31. *Tabanus hilaris* Wlk.	–	+	–	–
32. *T. striatus* Fab.	–	+	–	–
33. *T. jucundus* Wlk.	–	+	–	–
SARCOPHAGIDAE				
34. *Sarcophaga* sp.	+	+	–	–
35. *S. hirtipes* Wied.	–	–	–	+
TRYPETIDAE				
36. *Tephrostola reinhardi* Wied.	–	–	–	+
OTITIDAE				
37. *Chrysomyza aenea* W.	–	–	–	+
38. *C. demandata* F.	–	–	–	+
MILICHIIDAE				
39. *Milichia pubescens* Beck.	–	–	–	+
40. *Milichiella lacetipennis* Loew.	–	–	–	+
EPHYDRIDAE				
41. *Gymnopa albipennis* Loew.	–	–	–	+
Hemiptera				
PYRRHOCORIDAE				
42. *Dysdercus koenigii* Fab.	+	–	–	–
LYGAEIDAE				
43. *Graptostethus servus* Fabr.	+	–	–	–
Lepidoptera				
SATYRIDAE				
44. *Mycalesis* sp.	–	+	–	–
45. *Mycalesis* sp. near *mineus*	–	+	–	–
NYMPHALIDAE				
46. *Neptis hylas varmona* Moore	–	+	–	–
47. *Precis iphita* Cramer	–	+	–	–
48. *Euthalia nais* Foster	–	+	–	–

ACKNOWLEDGEMENTS

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24. DRAGONFLIES

A couple of years ago in the month of October, I had been to Maniadih, a village near Dhanbad in Bihar. There was a Jheel at one end of the village where I passed some delightful time watching brids and insects that disported in and around the Jheel.

I found a good number of dragonflies (*Aeshna*?) flying at high speed over the water of the jheel. There were at least six different species, some of them red and some yellow. The biggest of them was about four inches long with its body banded with black and white. It flew with a whirr which was quite audible when near. While watching them I suddenly found one such dragonfly flying with a big butterfly, possibly a crow (Danaid), judging by its big black wings flapping under the hold of the dragonfly. As the dragonfly sailed to and fro in the air, suddenly the wings of the butterfly drifted down to the water. The murderous dragonfly must have nipped them off. I could discern the wingless body of the victim held near the Jaws of the flying dragon.

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25. A NEW RECORD OF A SPECIES OF *SPILOSMYLUS* (NEUROPTERA: OSMYLIDAE) FROM INDIA

Introduction

Spilosmylus tuberculatus was confused for a long time with *Spilosmylus modestus* and *Spilosmylus japonicus* which were synonymised by Nakahara (1955) with *S. tuberculatus.* During the course of a study of Neuroptera from Maharashtra, I came across a single female specimen of *Spilosmylus tuberculatus.* The species is so far known only from Shikoku in Japan, Formosa, Philippines, Malaya and East Indies and is thus recorded for the first time from India.

Spilosmylus tuberculatus (Walker)

Spilosmylus tuberculatus Nakahara, 1955, *Kontyu,* 23: 11.

The following characters may be mentioned:

Wings: 1st crossvein from media ends on the 1st branch of radial sector and the bulla nearly circular in the forewing; Sc and R, of forewing with six pairs of black linear spots and with a black line in between each pair of spots in the subcostal area except between the apical pair; 2 cross-veins in the inner and a single in the outer gradate series of the right forewing and one in each of the inner and outer gradate series of the left forewing clouded with brown; pterostigma brown in both the wings; abdomen: gonapophysis laterales slender, broadest in the middle and with stylus; Spermatheca: with curved stem and expanded at the apex; glandula accessoria curled with a few blisters.

Material examined: INDIA: Maharashtra: Ambenali, near Pratapgad, Dist. Satara, 30.5.76. Coll. B. K. Tikader.

Remarks: In the presence of black linear spots with corresponding black lines in between and the structures associated with the genitalia the species may be confused with *Spilosmylus interlineatus* T. Jeder (1957) from Africa. But the ending of 1st crossvein from media to Rs before the 1st branch of Rs and the absence of brownish shaded spot in a crossvein just above the bulla in the forewing in *S. interlineatus* at once separate it from *S. tuberculatus.*

Acknowledgement

I am indebted to Dr. B. K. Tikader, Deputy Director, Western Regional Station, Zoological Survey of India for his keen interest and constant encouragement.

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26. INDIAN SPECIES OF THE GENUS *NEZARA* AMYOT AND SERVILLE (HEMIPTERA: PENTATOMIDAE)

(*With nine text-figures*)

An account is given of three species of the genus *Nezara* Amyot & Serville. *N. antennata* Scott., *N. viridula* (L.) and *N. indica* sp. n. have been described in detail. A revised key to species of *Nezara* Amyot & Serville is also provided. Material has been deposited in the Zoological Museum, Aligarh Muslim University, Aligarh, India.

Nezara Amyot & Serville

Nezara Amyot & Serville, 1843, Hem., p. 143 Type species: (*Nezara smaragdula* Fabricius =*Nezara viridula* (L.) designated by Kirkaldy, 1903, *Entomologist*, 36:231.

The distinguishing characters of this genus have been given in detail by Freeman (1940). One new and two known species are represented here. Freeman's (1940) key to species of *Nezara* Amyot & Serville has been revised in order to accommodate *N. indica* sp. nov.

Revised key to species of *Nezara* Amyot & Serville, based on male & female

1. Scent gland spout never elongate, but ear-like (Freeman 1940; figs. 8-10) 2
   — Scent gland spout elongate (Freeman 1940; figs. 11, 12), reaching middle of anterior edge of metapleuron. 10
2. Abdominal spine always short and rounded (Freeman 1940; fig. 4), evaporating area of scent gland large (Freeman 1940; fig. 8) 3
   — Abdominal spine longer and more pointed (Freeman 1940; figs. 6, 7), evaporating area of scent gland small (Freeman 1940; figs. 9, 10). 8
3. Pronotum not ridged. 4
   — Pronotum traversed by strong ridges, lighter in colour than the grooves. .. .. *N. niamensis* Dist.
4. Black spots smaller; antennae with definite green bands on some or all segments. .. 5
   — Broad Madagascan species; black spots on margin of first abdominal segment much larger than the spiracle; parameres as (Freeman 1940; fig. 24); antennae with segments 2-5 nearly all red. *N. soror* Schout.
5. Smaller narrower species (Freeman 1940; fig. 1); parameres bilobed (Freeman 1940; figs. 22, 23). 6
   — Large robust species (Freeman 1940; fig. 2); parameres trilobed (Freeman 1940; figs. 25, 26). 7
6. No black on antennae; prothoracic angles not prominent. .. .. *N. viridula* (L.)
   — Antennae banded with black on segments 3-5; prothoracic angles prominent; Asiatic species .. *N. antennata* Scott.
7. Black abdominal spots present; margin of whole insect narrowly red; parameres as in (Freeman 1940; fig. 25) *N. robusta* Dist.
   — Black abdominal spots absent; margin only red in reddish coloured varieties and than broadly so; parameres as in (Freeman 1940; fig. 26). .. .. *N. immaculata* Freeman
8. Abdominal spine longer (Freeman 1940; fig. 7). 9
   — Abdominal spine shorter (Freeman 1940; fig. 6); parameres somewhat variable, usually as in (Freeman 1940; fig. 27), never as *N. similis* (Freeman 1940; fig. 28). .. .. .. *N. naspirus* (Dallas)
9. Abdominal spine not extending beyond the hind coxae (Freeman 1940; fig. 7); 4th antennal segment with basal third green, rest reddish rust, 5th segment with basal third yellowish, rest reddish rust; margin of abdomen with black spots; body large, about 10-12 mm in length. .. .. *N. similis* Freeman
   — Abdominal spine very long, extending up to middle coxae (Fig. 9); 4th and 5th antennal segments red; margin of abdomen without black spots; spiracles black; body small, 7 mm in length. .. *N. indica* sp. nov.
10. Abdominal spine short as in *N. viridula* (L.)

(Freeman 1940; fig. 4); evaporating area large (Freeman 1940; fig. 11); parameres as (Freeman, 1940; fig. 29); smaller narrower species, shape more as *N. robusta* (Freeman 1940; fig. 2). .. .. *N. frontalis* (Westw.)

— Abdominal spine elongate, reaching middle coxae (Freeman 1940; fig. 5); evaporating area smaller (Freeman 1940; fig. 12); parameres as in (Freeman 1940; fig. 30); large very broad species (Freeman 1940; fig. 3). .. .. .. *N. orbiculata* Dist.

Nezara antennata Scott. (Figs. 1-3)

Nezara antennata Scott., 1874, *A.M.N.H.* (4) 14: 299

Nezara antennata Scott., Distant, 1902, *Fauna Brit. India,* 1:220

Nezara antennata Scott. Freeman, 1940. *Trans. R. Ent. Soc. Lond.,* 90:360

FEMALE:

Head: Greenish, densely punctate; distinctly wider than long in dorsal view, narrowing anteriorly and broadening posteriorly; eyes dark brown rounded and smooth; ocelli red, close to occipital margin; occipital margin convex; rostrum greenish brown, 4-segmented, 6 mm in length and extending up to hind coxae.

Antennae: 5-segmented, excluding a small ring segment between third and fourth segments; greenish except apical fourth of third, apical half of fourth and apical two-thirds of the fifth segment which are black; first segment short, twice as long as wide not reaching up to apex of head; segments 2-5 gradually increasing in length distad; segments 2nd and 5th eight times, 3rd and 4th seven times as long as wide.

Thorax: Greenish, densely punctate; pronotum well developed, twice as wide as long (7.3:3.5 mm), anterior margin with a pair of triangular brown patches, antero-lateral angles prominent; scutellum well developed, converging posteriorly, slightly longer than wide (4.8:4.5 mm), anterior margin with three white spots; metathoracic scent glands short and ear-like (Fig. 2).

Fore wings: Basal two thirds greenish, strongly sclerotised and densely punctate; apical one-third transparent, membraneous and impunctate; three times as long as wide (10.2: 3.5 mm), outer margin truncated.

Hind wings: Membranous, triangular in shape, slightly longer than wide (6.66:6.3 mm); submarginal vein with a triangular expansion at its apex.

Legs: Greenish except apices of tibiae which are brown; tarsi 3-jointed, second tarsal segment smaller than first and third tarsal segments separately; claws much sclerotised.

Abdomen: Greenish, punctate, distinctly longer than wide (6.3:5 mm), abdominal spine short and blunt not extending beyond the hind coxae (Fig. 3).

Body length: 13.5 mm.

Material examined: 5 ♀, INDIA: Uttar Pradesh, Aligarh, University Botanical Garden, on *Trifolium alexandrinum* Linn., 10.viii.1976 (M. Nayyar Azim).

Nezara viridula (Linn.) (Figs. 4-6)

Nezara viridula (Linn.); Distant, 1902, *Fauna Brit. India,* 1:220

Nezara viridula (Linn.); Freeman, 1940, *Trans. R. Ent. Soc. Lond.,* 90:357

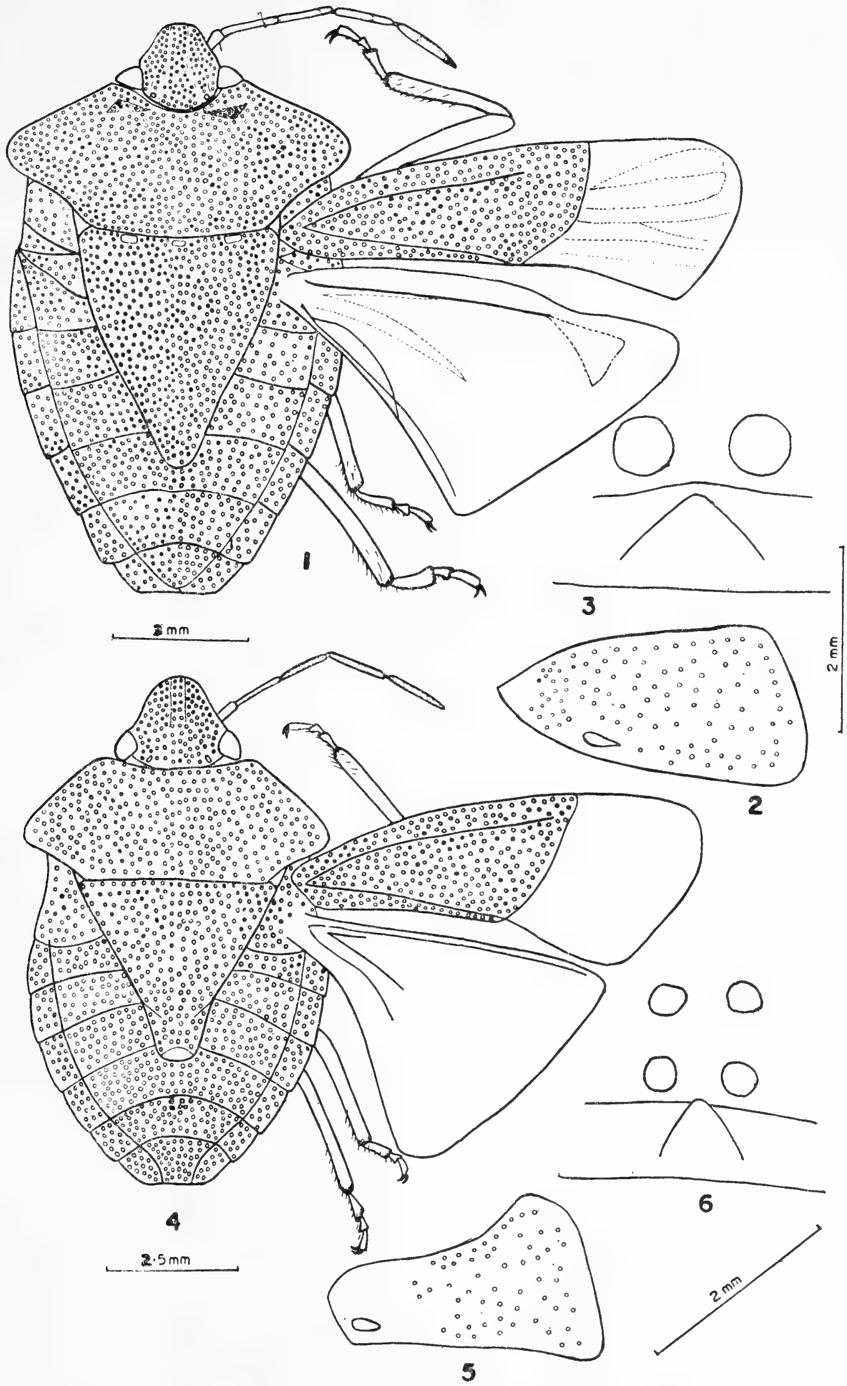
FEMALE:

Resembles *Nezara antennata* Scott. except in the following characters:

Antennae greenish except segments 3-5 red; segments 2nd and 5th nine times as long as wide; pronotum and scutellum without patches, apical end of scutellum brown; submarginal vein of hind wing without triangular expansion.

Body length: 10.5 mm.

Material examined: 4 ♀, INDIA: Uttar Pradesh, Aligarh, University Botanical Gar-



Figs. 1-3. *Nezara antennata* Scott., ♀ (1) Entire body; (2) Scent gland; (3) Abdominal spine. Figs. 4-6. *Nezara viridula* (Linn.), ♀ (4) Entire body; (5) Scent gland; (6) Abdominal spine.

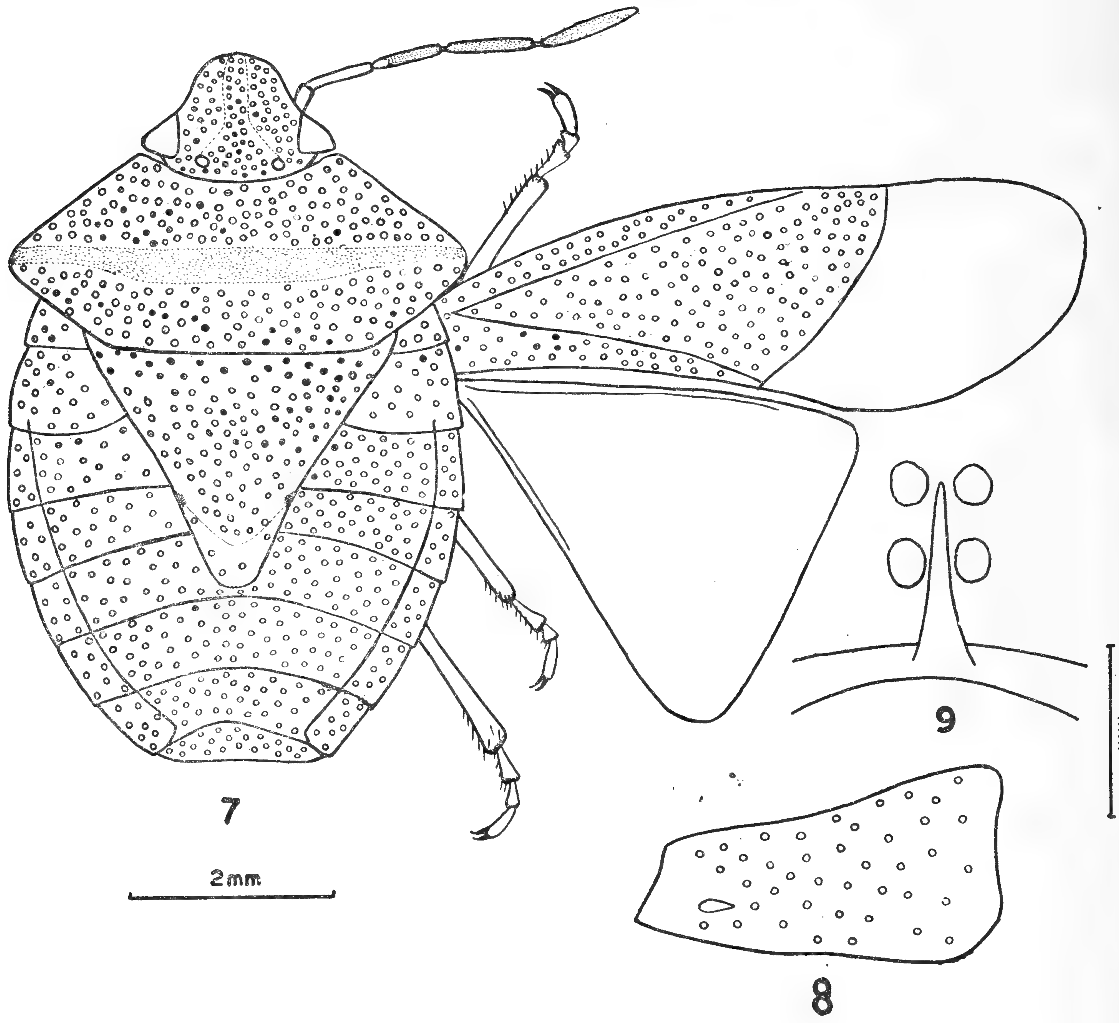
den, on *Trifolium alexandrinum* Linn., 20.viii.1976. (M. Nayyar Azim).

Nezara indica sp. nov. (Figs. 7-9)

FEMALE:

Head: Greenish, densely punctate, distinctly wider than long in dorsal view, narrowing anteriorly and broadening posteriorly; eyes red, triangular and smooth; ocelli red placed near to occipital margin; occipital margin convex; rostrum 4-segmented, reaching just beyond the middle coxae.

Antennae: 5-segmented, excluding a small ring segment between third and fourth; red except basal two segments which are green; 1st segment short, twice as long as wide,



Figs. 7-9. *Nezara indica* sp. nov., ♀ (7) Entire body; (8) Scent gland; (9) Abdominal spine.

reaching up to apex of head; segments 2nd and 4th six times, 3rd five times, 5th seven times as long as wide.

Thorax: Greenish, densely punctate except a transverse band on pronotum which is impunctate; pronotum well developed more than two times as wide as long (4.2:1.7 mm), antero-lateral angles prominent; scutellum well developed, converging posteriorly, slightly wider than long, a pair of dark patches present before the apex one on each side; metathoracic scent gland short and ear-like.

Fore wings: Basal two thirds greenish, weakly sclerotised and sparcely punctate; apical one-third transparent, membranous and impunctate; three times as long as wide (6.2: 2.2 mm), outer margin truncated.

Hind wings: Membranous, triangular in shape, slightly longer than wide (4.0:3.7 mm); submarginal vein without distinct triangular expansion at its apex.

Legs: Greenish except apices of tibiae which are brown; tarsi 3-jointed, second tarsal segment smaller than first and third tarsal segments separately; claws much sclerotised.

Abdomen: Greenish, punctate, distinctly longer than wide, lateral margins without black spots; abdominal spine long, extending up to middle coxae (fig. 9).

Body length: 6.9 mm.

Nezara indica sp. nov. is more closely related to *N. similis* Freeman, but differs from it in having long abdominal spine which extends up to middle coxae, margin of abdomen without black spots.

Holotype: ♀, INDIA: Uttar Pradesh, Aligarh, University Botanical Garden on *Trifolium alexandrinum* Linn., 20.viii.1976. (M. Nayyar Azim). *Paratypes*: 5 ♀ (Same data as for holotype).

ACKNOWLEDGEMENTS

We are deeply indebted to Prof. S. Mashhood Alam, Head, Department of Zoology, Aligarh Muslim University, Aligarh, for providing research facilities. Thanks are also due to Prof. Nawab H. Khan for encouragement.

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27. THE BLACK ANT, *CAMPONOTUS* SP., FEEDING ON UREA

I refer to Dr. Mahdihassan's note under this heading (1977, *J. Bombay nat. Hist. Soc.*, 74(1) : 197-199).

Some forty years ago, my doctor in Calcutta told me that he could confidently forecast the laboratory results of urine sent for sugar determination by observing the behaviour of *Camponotus* ants, of which there were numerous nests in his garden.

He said that the ants never made a mistake

and that samples which were subsequently proved to be sugar-negative were invariably ignored, whilst those that were sugar-positive had numbers of ants clustered above the surface of the liquid in the sample beakers.

I wonder, therefore, if Dr. Mahdihassan is correct in stating that urea in the urine is the attraction in these public latrines, and that the real explanation is that some of the users are diabetics, whose urine contains sugar, which is the actual attraction.

MOMBASA,
KENYA,
EAST AFRICA,
November 21, 1977.

D. G. SEVASTOPULO

28. DANAID BUTTERFLIES ATTRACTED TO *HELIOTROPIUM INDICUM* (BORAGINACEAE), AN ALKALOID CONTAINING PLANT

I am pleased to be able to add a little further information to Professor S. R. Amladi's very interesting note under this heading (1975, *J. Bombay nat. Hist. Soc.*, 72(2): 585-587).

The first references to this behaviour are to be found in the *Proceedings of the Entomological Society of London* [1926, 1:35, 36, 37. 1931, 6:77, 78, 79. 1936, 11(a):94] recording the attraction of *Tournefortia* spp. (Boraginaceae) to the males of various species of *Euploea* spp. on a number of Pacific Ocean Islands.

Very little more was written in this connection for a number of years until the early 1970s, when my friend Professor Dietrich Schneider of the Max-Planck-Institut fur Verhaltensphysiologie of Seewiesen, West Germany and his team began to take an interest and eventually showed that feeding on the withered *Neliotropium* was an essential precursor to the formation of the male hormone.

MOMBASA,
KENYA,
EAST AFRICA,
October 10, 1977.

D. G. SEVASTOPULO

29. AN UNUSUAL FOOD-PLANT FOR *ARGINA SYRINGA* CR.

Messrs B. N. Viswanath & B. L. Visweswara Gowda's record of the above species feeding on a monocotyledon—banana (*Musa* sp.)—(1975), *J. Bombay nat. Hist. Soc.*, 72(3): 871-2) is so far out of pattern that I feel bound to comment on it. Although Gaede, in Seitz *African Bombyces*, writes that many Callimorphinae are polyphagous, in contrast to the monophagous Nyctemerinae, all available food-plant records for *Argina* Hbn. and the allied genus *Amphicallia* Auriv. are *Crotalaria* spp. (Papilionaceae), furthermore, *Argina*

larvae, by preference, feed in the pods on the developing seeds. Le Pelley (*Agricultural Insects*) does record *Amphicallia solai* Druce, probably a synonym of *A. tigris* Btlr., f. *piceosignata* Bart., as feeding on *Schinus molle* (Anacardiaceae), but many of his records are suspect and this is almost certainly wrong: I have bred it on *Crotalaria*.

After all *Bombyx crotalariae* F. is a synonym of *Argina syringa*.

MOMBASA,
KENYA,
EAST AFRICA,
October 10, 1977.

D. G. SEVASTOPULO

30. BREEDING SEASON AND GESTATION PERIOD OF THE SCORPION, *HETEROMETRUS FULVIPES*

Certain amount of controversy exists with reference to the breeding season and gestation period of *Heterometrus fulvipes*. As early as 1891, Laurie estimated the period of gestation of *H. fulvipes* to be over 6 months. This estimate was based on the assumption that there is a definite breeding season in this species and that the earliest stages of development were found in October and the latest in May. However, Mathew (1956) was not able to find out the gestation period definitely and he suggested the possibility of the gestation period being much shorter than that suggested by Laurie. Occurrence of a definite breeding season was also contradicted by him.

During the course of a detailed study of the physiology of reproduction and development of the scorpion *H. fulvipes*, it has been possible to examine monthly samples of over 100 specimens over a period of 3 years and a clear cut picture about the breeding season and the gestation period was obtained. The developmental stages from the earliest stages of gastrula to the preparturition stages were divided into 8 groups based on length and external characters for characterizing the stage of development. Monthly samples of scorpions were dissected and the stages of development were noted. All the embryos of a given animal were always found to be in the same stage of development.

Table I gives the month and the percentage of animals carrying the embryos corresponding to the indicated stage of development. It could be noticed that majority of the gravid females collected in a month contained embryos belonging to only one stage and a lesser percentage of them contained embryos belonging to a stage preceeding or succeeding that stage. No batch of gravid females contained all the developmental stages. This clearly indicates the occurrence of a definite breeding season. Based on the data presented in Table I it could also be inferred that the gestation period extends over a period of about 11 months with the earliest stages appearing in the months July and August and the latest stages appearing in May and June.

While studying the courtship and mating behaviour of the scorpion *H. fulvipes* (Reddy 1975), readiness to court and mate and successful mating were noticed mostly during the months, July and August. It could therefore be taken to substantiate the data obtained here and the breeding season can be conveniently said to correspond to these months. Par-

TABLE I

DISTRIBUTION OF DEVELOPMENTAL STAGES IN THE MONTHLY SAMPLES OF GRAVID FEMALES OF *H. fulvipes*.

						Months					
Stages	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
I	68	29										
II	32	47	48	20								
III		24	52	40								
IV				40	45	21						
V					55	79	50	27				
VI							50	55	62	13		
VII								18	38	56	10	
VIII										31	90	100

The data represents percentage of gravid females carrying the embryos of a given stage.

turition was always recorded only during the months of May and June and never before or after. This lends further support to the occurrence of a breeding season. *H. fulvipes* thus resembles *H. swammerdami* which has a definite breeding season (Habibulla 1962) and differs from *H. scaber* which has no definite breeding season (Mathew 1956).

It is concluded that the scorpion *H. fulvipes* has a definite breeding season confined to the months July and August and a gestation period of about 11 months.

ACKNOWLEDGEMENTS

We are grateful to Dr. P. Govindan, Professor and Head of the Department of Zoology, Annamalai University, for providing the facilities and for his constant encouragement and interest. The award of the C.S.I.R. Junior Research Fellowship to the first author is also gratefully acknowledged.

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REDDY, T. GOPALAKRISHNA (1975): Courtship and mating in the scorpion *Heterometrus fulvipes*. *Bulletin of the ethological Society of India, 1* (2): 36-42.

31. A PRELIMINARY EXAMINATION OF THE PARASITES RECOVERED FROM THE INDIAN WILD DOG (*CUON ALPINUS*)

In December of 1975, the corpse of a female wild dog (*Cuon alpinus*) was recovered from the area surrounding the village of Wallathuttam, just east of the Mudumalai Wildlife Sanctuary in Tamil Nadu.

Following an autopsy she was found to be in her eighth week of pregnancy. Several specimens of endoparasites were isolated and preserved for identification. These samples, along with several specimens of ectoparasites and a collection of fecal samples were taken to the Veterinary College of Madras in Tamil Nadu. With the aid of C. M. Lalitha, professor of Parasitology, and her staff, these samples were identified.

In the fecal samples, eggs of the following Helminths were identified: *Ancylostoma* sp., *Trichuris* sp., *Moneizia* sp., and stray eggs of *Strongyle* sp. The latter may have been a result of some contamination.

Of those endoparasites recovered from the small intestine and colon, a tentative examination and identification was made based on the size and number of the Rostellar hooks; the mature and gravid segments obtained were of no value as they were not preserved on slides at the time of collection. As a result of this analysis, two species of Cestode were identified; *Taenia hydatigena,* and *Taenia pistiformis.*

Of the ectoparasites, two species of ticks; *Rhizecephalus haemaphysaloides* and *Haemaphysalis* sp. were identified. Only one species of flea, *Ctenocephalides felis felis* was recovered.

Further work in this area is being conducted in the Bandipur Sanctuary of Karnataka by A. J. T. Johnsingh of the A. J. College in Sivakasi, Tamil Nadu.

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July 22, 1977.

32. CRABS SUMMERING IN LAKESIDE HOTEL

Leonard Woolf in THE JOURNEY NOT THE ARRIVAL MATTERS his autobiography of the years 1939 to 1969, relates an observation which may interest readers of the *Journal*.

During a visit to Israel he and a companion arrived at a hotel on the shore of the Sea of Galilee two days before the hotel was due to close for the hot weather. Owing to a shooting incident in which the Syrians killed or injured an Israeli fisherman the hotel remained open for one day beyond the usual date, and Leonard Woolf, his companion, and three United Nations Commissioners investigating the occurrence were the only guests in the hotel on the last day. I proceed in the words of the author:

"We were sitting in the vast lounge hall after dinner when we saw suddenly a long procession of large and small crabs file past us and begin climbing up the staircase. When the hotel manager passed by us paying no attention to the long line of crabs, I asked him what it meant. He said that whenever the hotel closed down, it was immediately invaded by hundreds of crabs from the lake and they remained there, upstairs and downstairs, until the hotel reopened with the cool season."

65, PALI HILL ROAD,
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January 4, 1978.

D. E. REUBEN

33. DESCRIPTION OF ISOPOD *CIROLANA PARVA* HANSEN PARASITIC ON THE EYE BALLS OF DOLPHIN, *DELPHINUS DELPHIS* LINNAEUS WITH A KEY TO THE INDIAN SPECIES OF THE GENUS *CIROLANA* LEACH

(*With eleven text-figures*)

INTRODUCTION

Stebbing (1905) recorded *Cirolana parva* from Ceylon waters and Chilton (1924) reported it from Chilka lake, India. As there is no illustration to assist identification of *C. parva* in the earlier accounts of Stebbing (1905) and Chilton (1924) we have described the species with full illustrations in this paper. Seventeen specimens of *Cirolana parva* Hansen have been collected from the eye balls of the dolphin *Delphinus delphis* Linnaeus caught from Palk Bay, Mandapam on 30-xi-1971. The species of the genus *Cirolana* so far recorded from Indian region are *Cirolana willeyi, C. bovina, C. parva, C. venusticauda, C. sulcaticauda, C. pleonastica, C. fluviatilis. C. pustulosa* and *C. sulcata.* A synoptic key to the identification of these species is also given.

Distinguished by the presence of five free pleonal segments with a pleotelson. Endopods of pleopods 1 to 4 fringed with setae. Eyes absent or present. Peduncle of the second antennae five jointed. Molar process blade like with fine sharp and closely arranged teeth. Mandibles with lacinia mobilis; peraeopods ambulatory. Telson broad, sub-triangular; setae on the margin of the pleotelson and

uropod are elongated with fine bristles. Maxillipeds with hooks on second segment.

Cirolana parva Hansen (Figs. 1-11)

1890, *Cirolana parva* Hansen, *Vid. Selsk. Skr., Ser. 6, 3,* pp. 321, 340, pl. 2, fig. 6-6b, pl. 3, fig. 1-1d.
1902, *Cirolana parva* Moore, *Bull. U. S. Fish. Com., 20,* pt. 2, pp. 166-167, pl. 8, figs. 6-8.
1905, *Cirolana parva* Hansen, Stebbing, *Ceylon Pearl Oyst. Fish. Rep.,* part IV, No. 23, p. 12.
1924, *Cirolana parva* Hansen, Chilton, *Mem. Indian Mus., 5*(12), pp. 883-884.

Body smooth, telson broad, sub-triangular in shape., apical margin of telson rounded with 6 thick short setules of which three on the right side and three on the left side of the telsonic segment, close to the apical margin. The terminal segment also bears numerous fine setae along the margin, the outer ramus of the uropod is shorter and narrower than the inner which is very much broader, uropod margins furnished with fine setae and a few setules.

The third joint of the first antenna is longer than the first and second joints, the flagellum is longer than the peduncle and fifteen-jointed. Hansen (1890) described the flagellum as eleven-jointed, much shorter than the peduncle, Moore (1902) as eleven-to twelve-jointed and Stebbing (1905) as nine-jointed, little shorter than the peduncle. The second antenna about more than thrice as long as the first, last joint of the peduncle longer than the preceding, flagellum much longer than the peduncle about fortyone-jointed. Stebbing (1905) has described that the second antennae have the first three joints of the peduncle very short, fourth joint a little shorter than the fifth and flagellum 22-26 jointed. The second antennae closely resembled stebbing's description except in the flagellum being more jointed. The joints of the flagellum of the antennae were more numerous in the specimens described by Chilton (1924). The antipenultimate joint of the maxilliped possess three elongated setae on the outer margin. The maxilliped joints setose along their margin. The third palp of the outer margin of the maxilliped furnished with sixteen elongated setae and the setae are ornamented with fine bristles.

Maxilla I and II: First maxilla composed of two lobes—a sensory endopod and a biting exopod., there are long setae present on the two lobes. The second maxilla also possess long setae which serves as food strainers.

Mandibles: Mandibles are strong and serve as biting structures., the incisor process or the cutting part is thickly chitinised., the mandibles have a sensory palp of three articles—lacinia mobilis, molar teeth and mandibular palp. The mandibular palp is curved at the apex and the molar teeth is blade—like which is characteristic of the genus *Cirolana.*

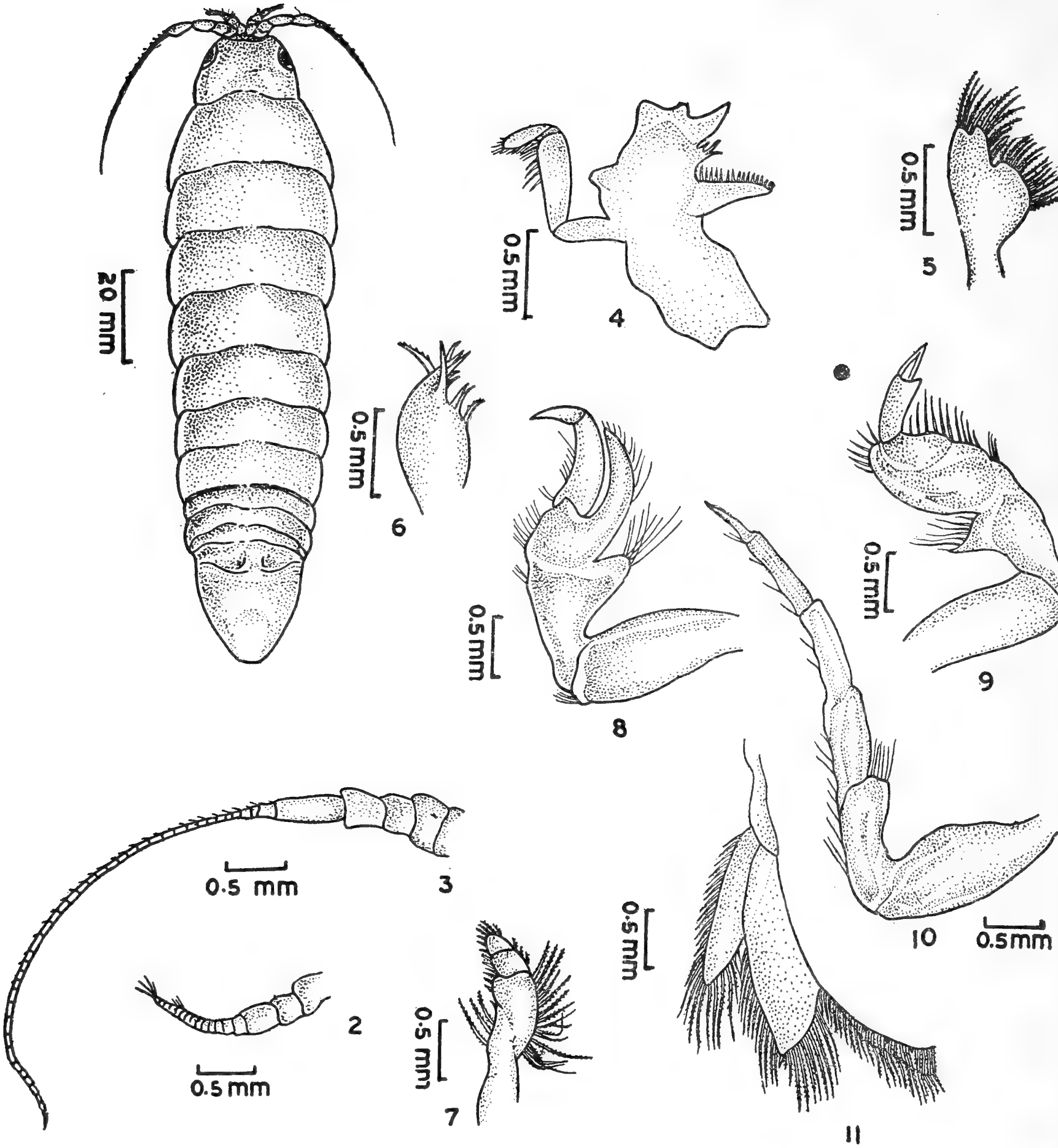
Size: The length and breadth of males ranged between 8.0 and 17.0 mm and 1.0 and 4.2 mm respectively. The length of females ranged between 8.5 and 17.0 mm and the breadth between 1.5 and 3.0 mm.

General Distribution: Gulf of Mexico, West Indies, Tale Sap, Sri Lanka and Chilka Lake.

Remarks: *Cirolana parva* has been reported for the first time from the Palk Bay region. Though Stebbing (1905) and Chilton (1924) have described *C. parva,* this report gives detailed description and illustration of the species.

Key to the Indian species of the Isopod genus *Cirolana* Leach 1818.

1. Frontal lamina pentagonal or hexagonal in shape, margin of cephalon medially produced., posterior margin of the peraeon segments and the pleon armed with spines., dorsal surface of telson without spines. .. .. *C. willeyi*



Figs. 1-11. *Cirolana parva* Hansen. 1. Dorsal view of the entire specimen; 2. First antenna; 3. Second antenna; 4. Mandible; 5. Maxilla I; 6. Maxilla II; 7. Maxilliped; 8. Peraeopod I; 9. Peraeopod II; 10. Peraeopod VII; 11. Telson and Uropod.

2. Frontal lamina is differently shaped in adult males., posterior peraeon segments not with distinct spines but with crenulate margin., pleon segments armed with spines, telson conical with a pair of large submedian spines. *C. bovina*
3. Frontal margin of sephalon slightly produced., peraeonal segment VII as broad as other peraeonal segments., eyes small not on border of cephalon., endopod of uropod reaching beyond the posterior margin of pleotelson. *C. parva*
4. Frontal lamina quadrangular in shape., margin of cephalon medially produced. .. .. *C. venusticauda*
5. Margin of cephalon slightly produced., transverse rows of spines along the posterior margin of the peraeon segments., telson with double row of tubercles or spines. .. *C. sulcaticauda*
6. Frontal margin of cephalon smooth, angular., frontal lamina narrow pentagonal, very broad at base., posterior margin of the posterior peraeon segments with one to three transverse rows of spines., pleon tuburculate., telson with a series of pairs of tubercles. .. .. *C. pleonastica*
7. Frontal margin of cephalon rounded., posterior peraeon segments and the pleon armed with spines., dorsal surface of the telson with two submedian spines followed by two parallel rows of three to four small spines. *C. fluviatilis*
8. Frontal margin of cephalon rounded., posterior margin of the peraeon segments with a single row of spines., telson with double row of elongated tubercles. .. .. *C. pustulosa*
9. Frontal lamina widening to middle., one to three transverse rows of spines along the posterior margin of the peraeon segments., pleon not tuberculate., telson grooved with a series of pairs of tubercles or spines .. *C. sulcata*

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September 3, 1977.

34. SHELL CHARACTERISTICS OF THE SPAT OF THE TWO SPECIES OF OYSTERS, *CRASSOSTREA MADRASENSIS* (PRESTON) AND *C. CUCULLATA* (BORN)

(*With two text-figures*)

Although a good deal of information is available on the biology of a few Indian oysters (Rao 1974), our knowledge on the morphology, settlement and growth of spat of many species is still insufficient. Settlement and growth of spat of two species are well known: *Crassostrea madrasensis* (Preston) (Hornell 1910; Paul 1942, Rao & Nayar 1956) and *C. gryphoides* Schlotheim (Durve & Bal 1962). An important aspect of oyster farming is the collection of the spat of the required species on the spat collectors and the removal of alien spat periodically to avoid competition for space and food. The knowledge of the shell characteristics of the spat of oysters will be useful in studying the early life histories and in maintaining spat collectors free from alien spat.

While studying the settlement of *C. madrasensis* in the Mulki estuary (13° 5′ N, 74° 46′ E), it was observed that the spat settled on the clutch belonged to two morphological variants. The spat collected from the estuary during 1974-1977 by the author and from a typical marine habitat (Menon *et al.* 1977) during 1973-1975 were examined to study the morphological characters. It was found that the spat settled in this region belonged to two species: *Crassostrea madrasensis* and *C. cucullata.* Rao & Nayar (1956) classified the young oysters (*C. madrasensis*) into spat and yearlings (oysterlings) without assigning clear cut morphological categorisation. In the present investigation, the growth stages from the time of settlement to the size attaining maturity are considered spat. The morphological characteristics of the shell of the spat of both species are described below. The structure and shape of the upper valves of spat belonging to different sizes are given in Figs. 1 and 2.

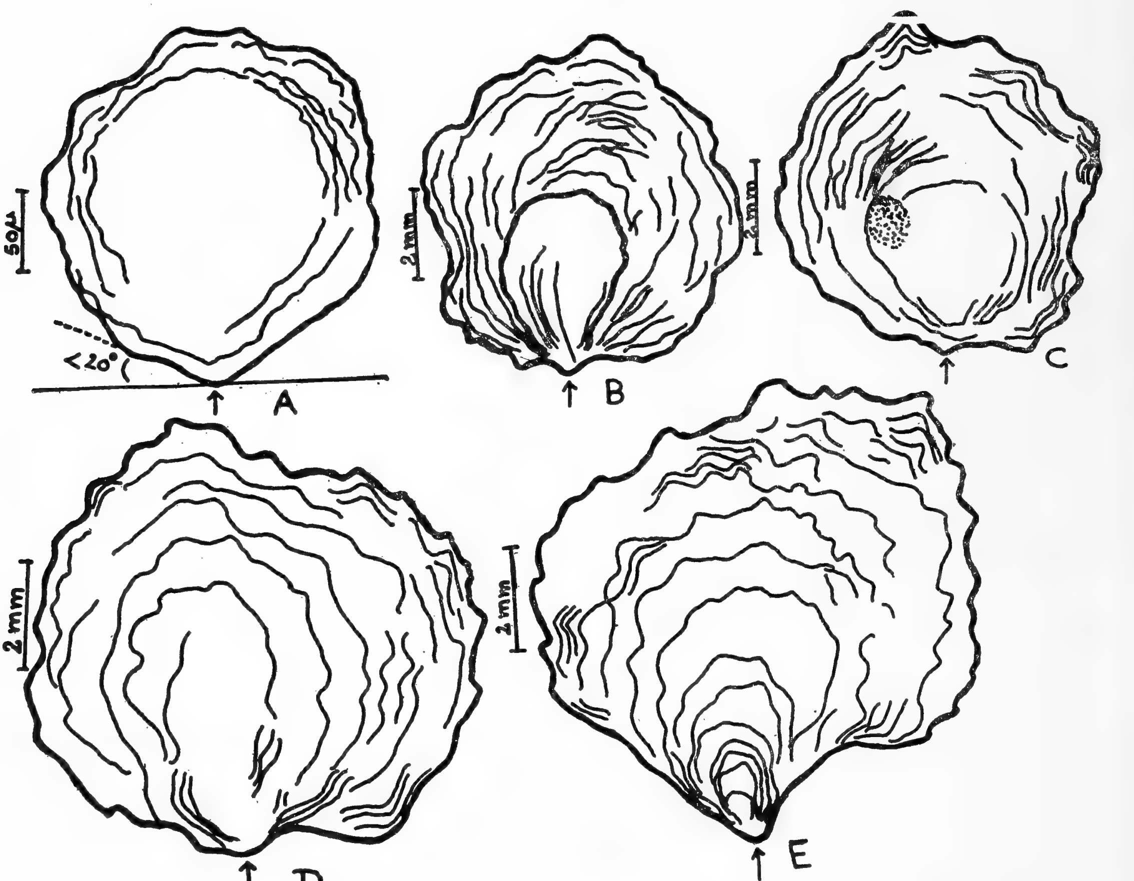

Fig. 1. A - E. Morphological characteristics of the upper valve of the spat of *C. madrasensis*. The nature of the inner phase of the upper valve is shown in A and C. Note the large foliations in marine spat (E).

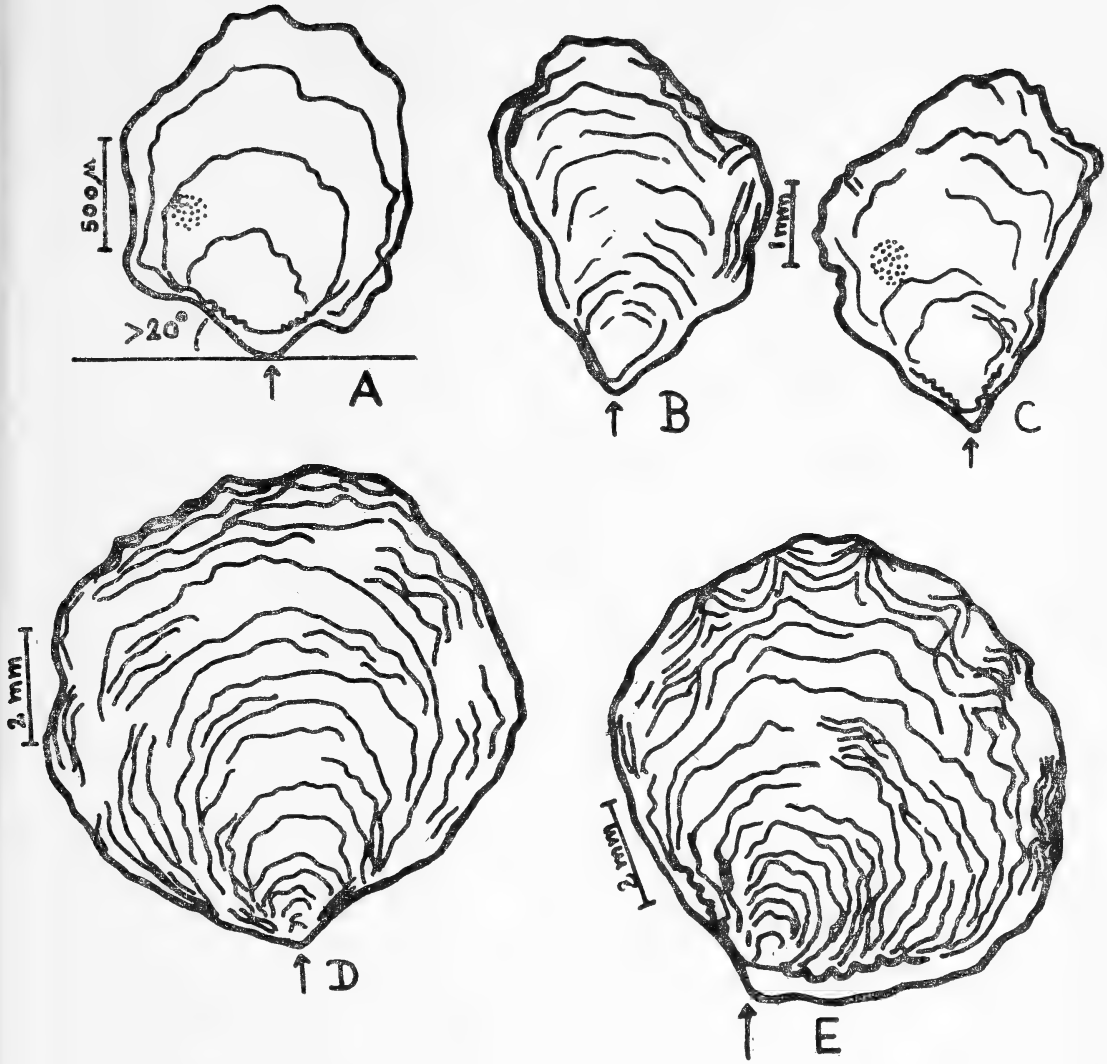

Fig. 2. A - E. Morphological characteristics of the upper valve of the spat of *C. cucullata*. Note the nature of the denticles on the inner phase of the upper valve in A, C and E.

The terms denoting morphological measurements used in the text are those of Rao & Nayar (1956).

The size of the spat of *C. madrasensis* examined ranged from 0.2 mm to 30.0 mm shell height. The lower (left) valve is flat and adhered to the substratum. The upper (right) valve has an outer convex and an inner concave surface. Both the valves are translucent, brown in colour in spat ranging in size 30 mm shell height and below. The valves are circular in spat of size 20 mm shell height and below,

longer than higher in 21-35 mm shell height, higher than longer in above 35 mm shell height. Generally, the anterior and posterior edges of the valve at the umbo region are at an angle of less than 20 degrees to the base line parallel to the hinge (Fig. 1A). The inner phase of both the valves are smooth and devoid of any denticles at the anterior and posterior margins. The muscle impressions on the upper valve, not very prominent, are placed laterally. The hinge is situated slightly interior to the umbo, forming a small 'beak' underneath.

The size of the spat of *C. cucullata* ranged from 1.0 mm to 25.0 mm in shell height. The lower (left) valve is flat, cemented permanently to the substratum in such a way that it is difficult to remove the lower valve from the substratum. The upper valve has an outer convex and an inner concave phase. Both the valves are translucent, pearly white in colour in spat of size upto 20 mm shell height. The valves attain an opaque dull white colour as growth advances. The valves are circular in outline in spat of 20 mm shell height and below. Spat larger than 20 mm shell height are higher than longer. Generally, the anterior and posterior margins of the valves at the umbo region are at an angle of more than 20 degrees to the baseline parallel to the hinge (Fig. 2A). The edges of the valves are generally sharp. The muscle impressions on the upper valves are not prominent, laterally placed on the inner phase. Denticles appear on the inner phase along the anterior and posterior margins of the valves at the umbo region in spat of 2 mm shell height. The hinge is situated right at the edge of the valves at the umbo region without forming a 'beak' underneath. A brownish band running from the umbo to the ventral edge is common on the upper valve.

The important shell characteristics which help in easy recognition of the spat of the two species are given in Table 1.

TABLE 1

IMPORTANT MORPHOLOGICAL CHARACTERISTICS OF THE SPAT OF *C. madrasensis* AND *C. cucullata*

C. madrasensis	*C. cucullata*
Both valves translucent, brown in colour in spat of size upto 30 mm shell height. Larger spat translucent white or brown.	Both valves translucent, pearly white in colour in spat of size upto 20 mm shell height. Larger spat opaque dull white.
Angle formed by the edge of the valve on the baseline parallel to the hinge generally not more than 20°.	Angle more than 20°.
Denticles absent.	Denticles present.
Hinge situated interior to the margin of umbo so as to form a 'beak'.	Hinge situated at the edge. No formation of 'beak'.

I am grateful to Dr. N. R. Menon for the experimental panels from the marine habitat and to Dr. P. S. B. R. James for critical comments.

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RAO, K. V. AND NAYAR, K. N. (1956): Rate of growth in spat and yearlings of the Indian backwater oyster *Ostrea madrasensis* (Preston). *Indian J. Fish., 3*: 231-260.

35. *GERANIUM PUSILLUM* L.—A NEW RECORD FROM GARHWAL HIMALAYA

For almost a century this pretty little *Geranium* has been known only from Kashmir, the description in the FLORA OF BRITISH INDIA being based upon a collection of Thomson from Kistawar 8000′ (2440 m.). On the basis of this plant, Edgeworth and Hooker f. generalised the distribution as Western temperate Himalaya. Subsequently this species has been known from a few other localities, like Srinagar and Baramula, but all, in Kashmir.

The discovery of this species now, further South-east, in the Garhwal Himalaya, at Brahm Khal, Barkot—4000′ (1220 m.), in Uttarkashi district, is of interest and support the original generalised distribution. It is very likely that this species will be found in other parts of the North-western Himalayas and to enable its identification, a detailed description is provided.

Geranium pusillum L., Syst. Nat. ed. 10, 2: 1144, 1759; Edgeworth and Hooker f. in Fl. Brit. Ind. 1: 432, 1875.

Deep-rooted, diffuse, much-branched, annual herbs, becoming reddish or purple in age. *Branches* prostrate, very slender, pubescent. *Leaves* sparsely glandular, reniform to orbicular, deeply 5-9-lobed or partite; segments cuneate, 3-lobed, mid-lobes long, side-lobes very small; petiole 0.8-2 cm long; stipules short. *Flowers* in axillary peduncles, bluish-purple, small, 6-7 mm in diam.; sepals 5, 2 mm long, glandular-hairy; petals 5, much smaller than the sepals; stamens 10, 5 fertile, *c* 1 mm long. Fruiting pedicles deflexed. *Fruits* 0.9-1.3 cm long; young carpels hirsute, on maturity smooth; beak slightly hirsute. *Seeds* brown, ellipsoid, minutely granulate, *c* 1.5 cm long, *c* 1 mm wide.

Flowering and fruiting—April; common in open grassy slopes. *Arora, C. M.* 37825, Brahm Khal, Barkot, 23rd April 1968 (BSD).

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DEHRA DUN,
February 7, 1977.

C. M. ARORA
R. PRASAD

36. *ARTHRAXON ECHINATUS* (NEES) HOCHST.—A NEW RECORD FROM HAMIRPUR DIST. (U.P.)

During a detailed study of the accumulated Poaceae collection at the Herbarium of the Botanical Survey of India, Dehra Dun (BSD), the authors came across a specimen—*M. A. Rau* 18240, from Charkhari, Hamirpur Dist., U.P., which proved to be of interest. The pronouncedly tuberculate lower glume of the sessile spikelet, readily identified it to *Arthraxon echinatus* (Nees) Hochst. The identity was further confirmed with reference to authentic material at the Herbarium of the Botanical Survey of India, Pune (BSI).

S. K. Jain, in his account of the genus *Arthraxon* (Journ. Ind. Bot. Soc. 51: 165-183, 1972) has stated that *Arthraxon echinatus* (Nees) Hochst. is *endemic* to Central and Southern India. S. K. Malhotra & Sirasala Moorthy have reported this species from Taroba National Park, Chandrapur Dist., Maharashtra—(J. Bombay nat. Hist. Soc. 70(1): 232. 1973). The present report of this species from Charkhari in Hamirpur Dist., U.P. is of interest extending its distribution to Northern India. Increased exploration, collection and careful study may thus show several of our hitherto endemic plants to be wide-spread.

ACKNOWLEDGEMENTS

We are grateful to Dr. A. S. Rao, Deputy Director, Botanical Survey of India, Northern Circle, Dehra Dun for encouragement and for going through the manuscript and to Miss U. R. Deshpande, Botanist, Western Circle, Pune for kindly confirming the identity.

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NORTHERN CIRCLE, DEHRA DUN,
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B. P. UNIYAL
S. C. SRIVASTAVA

37. NEW ORCHID RECORDS FROM KERALA STATE

While working on the floristic survey of Periyar Wildlife Sanctuary (Cardamom Hills of Western Ghats) a few orchids, namely *Oberonia gammiei* King & Pantl., *Gastrochilus dalzelli-anus* (Sant.) Sant. & Kapadia and *Acampe ochracea* (Lindl.) Hochr. were found which constitute new records since C. E. C. Fischer in Gamble's FLORA OF THE PRESIDENCY OF MADRAS (1928) or subsequent botanists do not cite these species from Kerala State. All the specimens are deposited in the Madras Herbarium of the Botanical Survey of India, Coimbatore.

Oberonia gammiei King & Pantl. in Journ. As. Soc. Bengal 66:578. 1897; Mitra, Fl. Pl. East India 1:300. 1958; Prain, Bengal Pl. 754. 1963 (rep. ed.).

Epiphyte. Stem short. Leaves 0.7—3.0 cm long, in two opposite rows, equitant, laterally compressed, oblong or linear-lanceolate, fleshy, green in colour. Racemes terminal, 3.8—5.5 cm long, slender. Flowers *c* 1.5 mm across, whorled, pale brown, pedicellate, bracteate. Bracts lanceolate, as long as the pedicel and ovary. Sepals subequal, ovate or oblong-elliptic, gland-dotted. Petals oblong, erose, gland-dotted. Lip manifestly 3-lobed with a concave disc at the base, gland-dotted; midlobe 2-lobulate with a sinus, erose. Column short.

Distribution: Bangladesh and W. Bengal.

Specimen examined: Idikki District: Sabarimala slopes, 700 m, 18.3.1973, *Sharma* 43932.

This small orchid was found as epiphyte on *Cyclostemon* sp. in the midst of evergreen forests.

Gastrochilus dalzellianus (Sant.) Sant. & Kapadia in J. Bombay nat. Hist. Soc. 59: 842. 1962.

Sarcochilus dalzellianus Sant. in Kew Bull. 1948: 498. 1948.

Saccolabium viridiflorum Lindl. in Journ. Linn. Soc. 3:36. 1858; Hook. f. Fl. Brit. India 6:63. 1890.

Santapau and Kapadia in their monograph (loc. cit.) pointed out that this species is endemic to Bombay state. The said species is readily distinguishable from the only recorded species of South India, namely *Gastrochilus calceolaris* (Buch.-Ham. ex Sm.) D. Don by its semi-circular, apiculate midlobe of lip with a conical spur.

Distribution: Maharashtra.

Specimens examined: Idikki District: Sabarimala slopes, 700 m, 18.3.1973, *Sharma* 43931.

This epiphytic orchid along with *Oberonia gammiei* was found on the same tree of *Cyclostemon.*

Acampe ochracea (Lindl.) Hochr. in Bull. New York Bot. Gard. 6:720. 1910; Sant. & Kapadia in J. Bombay nat. Hist. Soc. 60:95. 1963. *Saccolabium ochraceum* Lindl. in Bot. Reg. misc. 2. 1842; Hook. f. Fl. Brit. India 6:62. 1890; Prain, Bengal Pl. 768. 1963 (rep. ed.); R. S. Rao in J. Bombay nat. Hist. Soc. 61:323, 1964.

Available literature shows the distribution of this orchid as Eastern Himalayas, Bangladesh, Karnataka, Andhra Pradesh and Sri Lanka. The occurrence of this species in Kerala makes its distribution continuous from Himalayas in the north Sri Lanka in the south.

Even though Hooker f. (loc. cit.) mentioned Malabar as one of the localities of occurrence under the species based on the illustration of Jerdon the authenticity was doubtful since the subsequent floras did not include this species.

This orchid can easily be identified from other species of South India by its large spreading panicles and prominent subclavate spur on the lip.

Distribution: Meghalaya, Sunderbans, Andhra, Karnataka, Burma and Sri Lanka.

Specimens examined: Idikki District: Pachakanam, 950 m, 19.3.1973, *Sharma* 43941.

This species was found in open destroyed forest, epiphytic on *Bischofia javanica* Bl. near streams.

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B. D. SHARMA
N. C. RATHAKRISHNAN

38. OCCURRENCE OF THREE TAXA IN WEST BENGAL

The plants forming the subject of this note were collected from West Bengal, during a botanical tour by V. Narayanaswami and party 1949 and Dr. S. R. Das in the year 1975. As far as it is known to the authors, the plants under reference have not been recorded from West Bengal.

Alchornea tiliaefolia Muell.-Arg.

Specimen examined: Jalpaiguri, Buxa Bhu-

tan Road, 35 miles away from Jalpaiguri, W. Bengal, *V. Narayanaswami & Party,* 2546, collected on 16.v.1949, Alt. 3000 ft. (CAL).

Distribution: Common at higher altitudes in Assam, Sikkim & Bhutan Himalayas. It is now reported from the plains of N. Bengal showing its extension of distribution to the Bengal Plains probably a successful ecological adaptation.

Euphorbia helioscopia Linn.

Specimen examined: West Bengal, 24-Parganas, Kaikhali, March 1975, *S. R. Das,* 1057 (CAL).

Distribution: A common weed throughout the plains of Punjab & Siwalik tract ascending to *c* 2500 m. Introduced in the Nilgiris. It is now recorded from West Bengal plains in the District 24-Parganas, as a common weed in rice fields. We saw one specimen of this taxon collected from Bihar, Bhagalpur during identification and consultation of herbarium specimens in Central National Herbarium.

Chrozophora parvifolia Klotzsch ex Schweinf.

Specimens examined: West Bengal, 24-Parganas, Ichapur, "frequent in fallow field and Waste places", May 1975, **S. R. Das,** s.n. (CAL).

Distribution and notes:

These prostrate plants are common to western India & Deccan. Its distribution is not recorded yet from West Bengal. It is a distinct species from *C. rottleri* Keotzsch with its procumbent to prostrate habit and size of leaf.

INDIAN BOTANIC GARDEN,
HOWRAH 711 103,
March 4, 1977.

BARIN GHOSH
GOUR GOPAL MAITY

39. SOME NOTEWORTHY PLANT SPECIES FROM AGRA

During the course of our studies on the flora of Agra District we have come across a number of species which have been recorded for the first time from the area. Of these, the following species may be taken as new records for the Flora of Upper Gangetic Plain. The herbarium specimens cited in this work are preserved in the Department of Botany, R. B. S. College, Agra.

Cadaba fruticosa (Linn.) Druce in Rep. Bot. Exch. Cl. Brit. Isles 1913, 3: 415, 1914.

Cleome fruticosa Linn. Sp. Pl. 671, 1753.

Cadaba farinosa Forsk. F. Aegypt.—Arab. 68, 1775.

Cadaba indica Lamk. Encycl. 1: 544, 1785; FBI. 1: 172, 1872; Haines, Bot. Bih. & Or. 317, Rep. ed. 1961.

Fls. & frts. : Oct.—Jan.; AKS 575, Niyamatpur.

Blastania fimbristipula (Fenzl.) Kotschy & Peyr. Pl. Tinn. 15, t. 7, (1865-1866); Cogn. in Monog. Phan. 3: 628, 1881 and in Engler's Das Pflanzenr. 4, 275. 1, 133, 1916; Chakravarty, Ind. Journ. Agric. Sc. XVI. 1: 79, 1946.

Bryonia fimbristipula Fenzl. Kotschy Iter Nub. 205, 231, 1841, in Flora, 313, 1844.

Ctenolepis cerasiformis Clarke, Hook. f. FBI. 2; 630, 1879.

Fls. & frts.: Mar.-May; AKS 830, Bichpuri Campus.

Psammogeton biternatum Edgew. in Trans. Linn. Soc. XX. 57; FBI. 2: 719, 1879.

Fls. & frts.: Mar.-May; AKS 870, Near

Jamuna bridge Power Station.

Ageratum houstonianum Mill. Dict. (ed. 8) n. 2, 1768; Koster in Blumea 1: 490, 1953.

A. mexicanum Sims. Bot. Mag. t. 2524, 1825; Hoffm. in Pfam. 4: 137, 1894.

A. conyzoides L. var. *mexicanum* DC. Prodr. 5: 108, 1836.

Fls. & frts.: Jan.-Apr.; AKS 31, Salempur.

Soliva anthemifolia (Juss.) R. Br. in Trans. Linn. Soc. 12: 102, 1817; Bhattacharya, U.C. in Bull. Bot. Surv. Ind. 5: 375-376, 1963.

Gymnostylis anthemifolia A. Juss. in Ann. Mus. Par. 4: 262, 1804.

Fls. & frts. Jan.-Apr.; AKS 689, Salempur.

Heliotropium curassavicum Linn. Sp. Pl. 130, 1753; Gambl, Fl. Madras 2: 630, Repr. ed. 1956; Raizada & Sharma, Ind. For. 88(5): 356-369, 1962.

Fls. & frts.: Aug.-Dec.; AKS 279, Kiraoli.

Nonnea pulla Lamk. et DC. Fl. Fr. 3: 626, 1805; FBI. 4:169, 1883; Raizada, M.B., Ind. For. 76: 489-497, 1950.

Fls. & frts.: Feb.-Mar.; AKS 632, Poiya ghat.

Hyptis suaveolens (Linn.) Poit. in Ann. Mus. Hist. Nat. Par. 7: 472, t. 29, f. 2, 1806; FBI. 4:630, 1885; Haines, Bot. Bih. & Or. 772, Repr. ed. 1961.

Ballota suaveolens Linn. Syst. ed. 10, 1100, 1759.

Fls. & frts.: Aug.-Nov.; AKS 368, Bichpuri campus.

Achyranthes aquatica Br. Prodr. 417; FBI. 4: 730, 1885; Haines, Bot. Bih. & Or. 805, Repr. ed. 1961.

Fls. & frts.: Sept.-Nov.; AKS 919, Salempur.

Alternanthera paronychioides St. Hill. Voy. Bras. 2: 439, 1833; Raizada in Ind. For. Rec. 1: 233, 1939.

Fls. & frts.: Mar.-Oct.; AKS 101, Poiya ghat.

Laportea interrupta (Linn.) Chew in Gard. Bull. Singapore 19: 200, 1965.

Utrica interrupta Linn. Sp. Pl. 985, 1753.

Fleurya interrupta (Linn.) Guad. in Bot. Freyc. Voy. 497, 1826; FBI. 5: 548, 1888.

Fls. & frts.: Nov.-Dec.; AKS 275, Shahjahan garden.

Bulbostylis subspinescens Clarke in FBI. 6: 652, 1893; Haines, Bot. Bih. & Or. 967, Repr. ed. 1961.

Fls. & frts.: July-Sept.; AKS 447, Kitham.

Lolium remotum Schrank var. **aristatum** (Doell) Aschers, in Fl. Brabd. 1: 876, 1864.

L. linicolum var. *aristatum* Doell in Fl. Bad. 1: 113, 1857.

Fls. & frts.: Jan.-Mar.; AKS 638, Jhirna nala.

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A. K. SHARMA
J. S. DHAKRE

DEPARTMENT OF BOTANY,
R.B.S. COLLEGE, AGRA,
December 28, 1976.

40. MORPHOLOGICAL VARIATIONS IN *SILENE INDICA* ROXB. (CARYOPHYLLACEAE) DUE TO CHANGE IN HABITAT—A STUDY WITH ALLIED WALLICHIAN SPECIMENS

The Himalayan herb *Silene indica* Roxb. grows in alpine to subalpine regions, 3000-5000 m, from Kashmir, Western Himalaya to Arunachal, Eastern Himalaya, and Tibet. It is frequent in the Central Himalaya.

Silene indica Roxb. ex DC. Prodr. 1:368. 1824. Typus: Nepal, 1821, *Wallich* in Wall. list no. 624 (Holo. G-DC; iso. G, K, E, CAL); D. Don, Prodr. Fl. Nepal. 216. 1825; Roxb. Fl. Ind. ed. Carey, 2:446. 1832. Type: Roxb. icon 1555 (K, CAL). *Lychnis indica* (Roxb. ex Otth) Benth. in Royle, Illustr. Bot. Himal. 1:81. 1934; Edgew. & Hook. f. in Fl. Brit. India 1:225. 1874; *Melandrium indicum genuinum* Rohrb. Linnaea 36:234. 1869-70; *Lychnis nutans* Royle ex Bentham in Royle, Illustr. Bot. Himal. 1:80. 1834. Typus: "*L. ciliata* Gossain Than, *Wallich* in Wall. list no. 621 (BM, G, K, P, OXF, CAL); *Silene thomsonii* Majumdar, J. Indian Bot. Soc. 42: 650. 1963.

In the wild condition the plant flowers during July to October and fruits during September-October. The type specimen *Wallich* 624 has been studied and characters noted. This specimen was prepared from plants growing wild in Nepal.

Dr. F. Buchanan donated some plant materials of *S. indica* Roxb. from Nepal to the East India Company's Botanic Garden at Calcutta, in 1802. The annual erect herb was cultivated in the garden since that time. Later on the specimen *Wallich* 624 C was prepared from this cultivated plant and was listed by Dr. N. Wallich in his "A numerical list of dried specimens of plants........" p. 235 (Additions & corrections). This cultivated *Silene indica* was stated by Dr. William Roxburgh in his "Hortus Bengalensis, or A Catalogue of Plants growing in the Honourable East India Company's Botanic Garden, Calcutta, Serampore, 1814" in page 34, to bear flower during the months of March to May, and the seeds were stated to mature during April to June. The abbreviation HBC means "Hortus Botanicus Calcuttensis."

From the natural environment of moderately dry conditions in the high altitudes of Nepal Himalaya, the plant was brought and grown in an extremely moist and moderately saline soil in the plains at the Botanic Garden, Calcutta. Due to this drastic change in habitat, the plant acquired some altered characters which are shown in the following table:

Wall. 624 (wild)	Wall. 624 C (HBC, cult.)
1. Leaf smaller, upto 3.5 cm long.	1. Leaf larger, upto 7.5 cm long.
2. Inflorescence a regular dichotomus cyme, moderately clothed with scabrid hairs.	2. Inflorescence not yet fully open, densely clothed with about 1.5 mm long flexuous hairs.
3. Calyx 13 mm long, moderately scabrid hairy, teeth triangular, 3 mm long, with scarious margin.	3. Calyx 17 mm long, densely hairy, teeth narrow, linear, 6 mm long, without a scarious margin.
4. Petals a little exceeding the calyx (1-2 mm).	4. Petals appearing much more exceeding the calyx, due to the narrow and patent nature of calyx teeth.
5. Fl. July-Oct., Fr. Sept.-Oct.	5. Fl. March-May, Fr. Apr.-June.

The cultivated plant successfully produced flowers and fruits, but at a different time. The growth and density of hairs in the specimen 624 C may be due to the saline condition of soil in which it was grown.

The Eastern Himalaya also has a moist type of environment, differing from the relatively dry climate of Nepal, due to which *S. indica* growing in the Eastern Himalaya naturally have larger leaves and some other characters different from those of the type from Nepal, "*Wallich* 624". The wide range of variation in the vegetative and reproductive parts is due to the different habitats in which the plant is growing.

On examining the specimen Wall. list no. 621 with reference to the specimen Wall. list no. 624, it has been found that the two so called taxa do not have considerable difference between them. Hence *L. nutans* Royle may better be merged with *Silene indica* Roxb., as done by G. Bocquet in Candollea 22:12 (1967). As a result of this merging, the name *Silene thomsonii* Majumdar (1963) proposed earlier for *Lychnis nutans* Royle, also becomes a synonym of *Silene indica* Roxb.

N. C. MAJUMDAR

BOTANICAL SURVEY OF INDIA,
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41. *KALLSTROEMIA PUBESCENS* (DON) DANDY—A NEW RECORD FOR MAHARASHTRA STATE

(*With a text-figure*)

A persual of the available literature shows that in the State of Maharashtra the family Zygophyllaceae is represented by only six genera, namely *Tribulus, Seetzenia, Peganum, Zygophyllum, Fagonia* and *Guaiacum.* So far the occurrence of the genus *Kallstroemia* Scop. in the State of Maharashtra has not been recorded. As far as I am aware, the only record of this genus in India is by Bennet (1965).[1] He recorded the occurrence of *Kallstroemia pubescens* (Don) Dandy. from Howrah District, West Bengal. The present report is the second record of *Kallstroemia* Scop. for the Indian flora and the first record of Maharashtra.

[1] BENNET, S. S. R. (1965): Genus *Kallstroemia* Scop. (Zygophyllaceae)—New to Indian flora. *Indian Forester 91*(5): 281-283.

Kallstroemia Scop. is represented by the species *Kallstroemia pubescens* (Don) Dandy. This species, a native of Tropical America, was collected from Gorepeth, Nagpur. Only a few plants were growing luxuriantly along the roadside, near a newly constructed wall, during the monsoon season in August 1976.

Kallstroemia pubescens (Don) Dandy in Kew Bull. 1955: 138.

Tribulus pubescens Don, Gen. Syst. 1: 769, 1831.

Diffuse procumbent herb, stem including branches 20-50 cm long, pubescent with white hairs, younger parts densely pubescent; leaves 2-5 cm long, abruptly pinnate, usually opposite, occasionally alternate towards the base of the branches, when opposite one of each pair alternately smaller, rachis 1-3.5 cm long, pub-

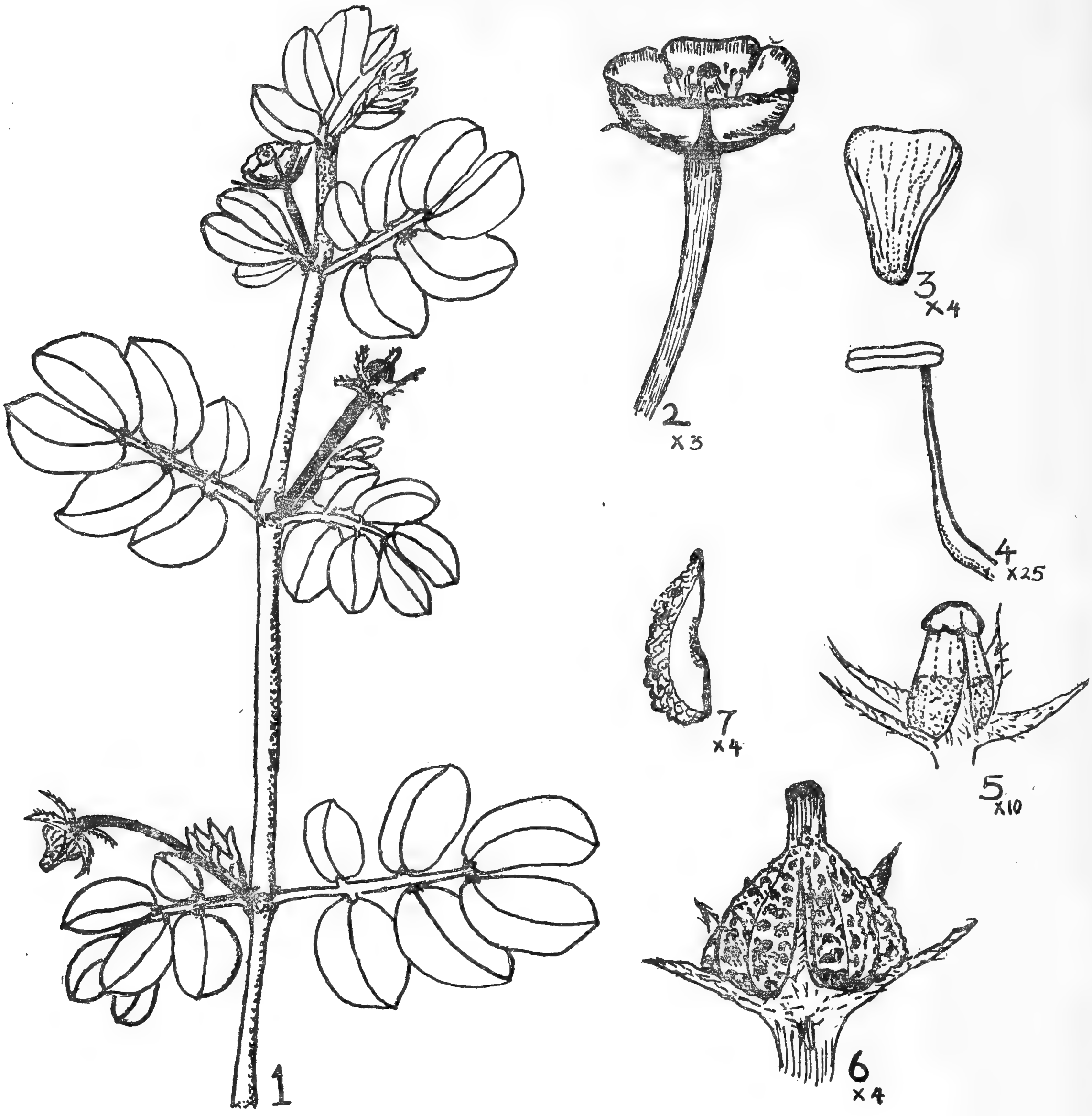

Fig. 1. *Kallstroemia pubescens* (Don) Dandy
1. Part of the plant; 2. flower; 3. petal showing forked veins; 4. stamen; 5. flower without sepals and stamens; 6. fruit; 7. coccus.

escent, leaflets in 2-4 unequal pairs, terminal pairs largest, 1.2-1-8 cm × 0.7-1.1 cm, elliptic or narrowly elliptic, entire apiculate, margin and surfaces hairy, stipules 3-5 mm long, linear, lanceolate, hairy; flowers solitary, axillary or leaf opposed, pedicels at length slightly thickening upwards, pubescent 1.2-1.8 cm long, sepals 5, each 4.5-6 mm long, narrowly lanceolate, accuminate, densely pubescent; petals 5, each 6-7 mm long, attractive yellow, obovate, veiny, veins forked at the tip, stamens 10, those opposite the petals larger and alternate ones smaller with conspicuous stalked glands at base; ovary 8-12 lobed, 8-12 celled, one pendulous ovule in each cell; style stout, conical, 10 furrowed; stigma capitate, 10 ribbed; fruit separating in to 8-12 tubercled cocci; cocci one seeded.

I wish to express my sincere thanks to Shri M. V. Mirashi, Principal, Government College, Aurangabad, for his kind help in identification of the plant and to the Director, Botanical Survey of India, Calcutta, for confirming the identification.

A. V. BHIDE

BOTANY DEPARTMENT,
INSTITUTE OF SCIENCE,
NAGPUR,
March 8, 1977.

42. A NOTE ON DISTRIBUTION OF SOME GRASSES IN ASSAM

The most comprehensive work on the grasses of eastern India was published by Dr. N. L. Bor in 1940, as a part of the FLORA OF ASSAM (Kanjilal *et al.* 1934-1940).

In 1960 Bor published an account of grasses of India as a whole, but notes on distribution and description are very brief in this work. Some studies were therefore undertaken for assessing the present position of the family Poaceae in the reorganised State of Assam. The material lodged in Assam Herbarium was studied and a number of fresh collection trips were undertaken. The studies led to discovery of several new distributional records.

Agrostis myriantha Hook. f.

This species was reported earlier from Sikkim, Naga Hills and higher altitudes in Meghalaya (Hooker 1896; Bor 1940, 1960). It has also been reported from Kurseong in north Bengal (Matthew 1966) and Kothong in Tirap district of Arunachal Pradesh (Deb & Dutta 1974).

This grass does not seem to have been reported from the present Assam or any area in the plains of Assam. A specimen collected by Kingdon-Ward (20051) in 1950 from an area near Sadiya has been seen in the Assam Herbarium. Sadiya is located in the plains of Assam. The altitude of Sadiya is about 200 m.

An effort was made to find out the exact location of Kingdon-Ward's collections in 1950 with the help of this book PILGRIMAGE FOR PLANTS (1960). This reference did not help much except that it was confirmed that this collection was made in one of his journeys through Sadiya. This seems to be the first report of this grass from plains in Assam. Hooker (1896) mentioned two varieties of this grass. Bor (1940, 1960) commented that one seems to be only a robust form of the other and consequently did not maintain Hooker's varieties. Ward's specimen is rather slender and has distinct oblong ligules and agrees with description of Hooker's var. *sikkimensis,* which

was described from Sikkim.

Coelorhachis khasiana (Hack.) Stapf ex Bor

This grass has so far been reported from Sikkim and Khasi and Jaintia Hills in Meghalaya, extending eastwards to Burma (Bor 1940, 1960). Two collections of this grass from Goalpara district made by Dina Nath (12724) in Nov. 1935 from Bamba, and by G. K. Deka (12739) from Malbhog also in the same month, have been seen in our Herbarium. This is the first report of this grass from the plains of Assam.

Polypogon fugax Nees ex Steudel.

Till 1966, this grass was believed to occur only in higher altitudes (Bor 1940, 1960). Jain 1966) reported its occurrence in the plains of Bengal. We have seen two collections by Kingdon-Ward (19506 and 20089) collected from near Sadiya in 1950. As stated above, Sadiya is located in the plains of Assam and this seems to be the first report of this grass in the plains of Assam; and this report, as well as that of Jain (1966), suggest that this species does sometimes occur in the plains.

Pseudoraphis spinescens (R. Br.) Vickery

The genus *Pseudoraphis* is represented in India by 3 species namely *P. brunoniana* Griff., *P. minuta* (Mez) Pilger and *P. spinescens* (R. Br.) Vickery. First two are reported to be common in eastern India (Bor 1940). *P. spinescens* is distinguished from the other two by size of spikelet (4-6 mm long). The species has 3 varieties, namely *P. spinescens* (R. Br.) Vickery var. *spinescens,* var. *depauperata* (Nees) Bor and var. *subglabra* (Thw. ex Trim.) Bor. The last two varieties are reported by Bor (1960) to occur in Ceylon, though Hooker (1896) records the distribution of var. *depauperata* also from peninsular India and Bengal. The var. *spinescens* is reported from northern, western and southern part of India, but not from eastern India (Prain 1903).

A grass collected by the senior author from Fakiragram has been matched in Central National Herbarium (Calcutta) as *Pseudoraphis spinescens* var. *spinescens.* It may be mentioned here that the characters distinguishing the varieties of this species are not very distinct. The Assam specimen has characters primarily of var. *spinescens.*

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B. NEOGI
S. K. JAIN

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SHILLONG 793 003,
MEGHALAYA,
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43. NEW LOCALITIES FOR LEPTOSPORANGIATE FERNS IN RAJASTHAN, INDIA

Leptosporangiate ferns in Rajasthan have mostly been reported from Mt. Abu, the highest peak of Aravalli ranges in the state (Sutaria 1941, Mahabale & Kharadi 1946, Raizada 1954, Bir & Verma 1961, Kanodia & Deshpande 1962 and Mital 1969). The few exceptions are reports of *Dryopteris parasitica* (L.) O. Ktze. from Naldeshwar, in Alwar district (Vyas 1964) and *Pityrogramma calomelanos* Link., *Pteris cretica* L. and D. *parasitica* from Parshuram hills in Udaipur district (Vyas 1965). Moreover the xerophytic ferns *Actiniopteris radiata* (Swartz) Link. and *Adiantum caudatum* L. and the water ferns *Marsilea* and *Azolla* occur widely all over the state (Mital 1969). A recent survey of the state, especially the southeactern region has revealed many new localities for leptosporangiate ferns. In most cases these newer localities are depressions in the plateaux regions adjoining Aravalli and Vindhya ranges providing appropriate humidity (especially during rainy season) and secluded habitats for natural occurrence of these ferns. A brief description of these new localities along with the older ones (Mt. Abu, Parshuram hills and Naldeshwar) and the ferns recorded from these forms the subject matter of this communication.

MOUNT ABU—A hill station, being the highest point between Himalayas and Nilgiris, in Sirohi district of south east Rajasthan, it is the best known fern locality of the state. In a survey carried out in the month of October 1975 & 1976 the following fern taxa were recorded.

1. *Cheilanthes albomarginata* Clarke
2. *C. farinosa* (Forsk.) Klf.
3. *Nephrolepis cordifolia* (L.) Pr.
4. *Tectaria macrodonta* (Fee) C. Chr.
5. *Athyrium falcatum* Bedd.
6. *A. schimperi* Moug. ex Fee
7. *A. parasnathense* (Clarke) Ching
8. *A. puncticaule* (Bl.) Moore
9. *A. pectinatum* (Wall.) Pr.
10. *A. hohenackerianum* (Kze.) Moore
11. *Hypodematium crenatum* (Forsk.) Kuhn
12. *Asplenium pumilum* var. *hymnophylloides* (Fee) Clarke

We could not find the following ferns reported earlier from Mt. Abu inspite of a thorough search of this area.

Cheilanthes belangeri (Bory) C. Chr. reported by Kanodia & Deshpande 1962; *Pteris vittata* Linn. reported by Bir & Verma 1961; *Dryopteris cochleata* (Don) C. Chr. reported by Mital 1969; *Cyclosorus dentatus* (Forsk.) Ching reported by Bir & Verma 1961 and Mital 1969;a *Asplenium lunulatum* Sw. reported by Kanodia & Deshpande 1962.

PARSHURAM HILLS—This locality consists of hilly area covered by thick forest around Fort Kumbhalgrah in Udaipur district of Rajasthan and forms a continuation of the Aravalli ranges from Mt. Abu. Following fern taxa were recorded during a survey in October 1975.

1. *Cheilanthes albomarginata*
2. *C. farinosa*
3. *Hypodematium crenatum*

We could not locate any plants of *Pityrogramma calomelanos, Pteris cretica* and *Dryopteris parasitica* reported by Vyas (1965) from this locality.

NALDESHWAR—It is situated in Alwar district and although thickly forested not many pteridophytes occur in this region. We could record only *Cyclosorus dentatus* from this locality apart from the ubiquitous *Actiniopteris radiata* and *Adiantum caudatum*. Vyas (1964) reported *Dryopteris parasitica* from here but we did not find a single plant of this fern during our survey in August 1975 & 1976.

MAINAL—This locality forms a natural depression in flat plateaux about 45 km from Bhilwara town in Rajasthan. We recorded the following ferns in a survey of this locality in September 1975.

1. *Pteris vittata* Linn.
2. *Hypodematium crenatum* (Forsk.) Kuhn

This is a new locality for both these ferns in Rajasthan.

JOGANIYAMATA TEMPLE—This again is a natural depression about 5 km from Mainal and the two ferns found here are again *Pteris vittata* and *Hypodematium crenatum*.

RAMESHWAR—This locality is situated about 7 km from the town of Bundi in south east Rajasthan and forms a natural depression. The following fern taxa were found growing at this locality in August 1975 and are being recorded for the first time from this place.

1. *Hypodematium crenatum*
2. *Cyclosorus dentatus*

BHIMLAT—A natural depression about 28 km from Bundi this locality was found to possess pure formations of *Cyclosorus dentatus* when visited in September 1975 and 1976. A few plants of *Hypodematium crenatum* were also found here.

GWAPERNATH—About 11 km from Kota in south east Rajasthan this locality is one of the richest after Mt. Abu for leptosporangiate ferns from where Sharma & Bhardwaja (1976) recorded *Selaginella rependa* for the first time in Rajasthan. It also forms a natural depression. The ferns recorded from here, again for the first time are listed below. The survey was carried in October 1975.

1. *Cheilanthes albomarginata*
2. *C. farinosa*
3. *C. belangeri*
4. *Pteris vittata*
5. *Hypodematium crenatum*

SITABARI FOREST—This thick forest on rocky soil is about 50 km east of Kota. It is here that we found, for the first time the Thelypteroid fern, *Ampelopteris prolifera* (Retz.) Copel. covering the forest floor. It is a new record for the occurrence of this fern in Rajasthan. *Ceratopteris thalictroides* (L.) Brongn. reported earlier by Singh (1970) was also found growing along water channels in this forest.

JHALAWAR—Around this town in south east Rajasthan only *Ceratopteris thalictroides* was found growing in water channels near the forest nursery. This is a new record for the occurrence of this fern in this region.

BANSWARA—A district forming the extreme south of Rajasthan. It abounds in *Ceratopteris thalictroides.* This water fern was found growing in water channels of rice fields near the city and in a stream at Tripura-Sundari about 15 km north of Banswara. The survey was carried out in February 1975.

Thanks are due to University Grants Commission, New Delhi, for sanctioning an Ad-

vanceed Research Project on Pteriodophytes of Rajasthan. Principal N. M. Kothari of Government College, Ajmer provided facilities and encouragement for this work.

BOTANY DEPARTMENT,
GOVERNMENT COLLEGE,
AJMER, 305 001,
November 2, 1977.

T. N. BHARDWAJA
A. K. YADAV
C. B. GENA

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44. PINE FORESTS IN NEPAL

In the present paper, I have described the area and places where Pine forests are located in Nepal. It is based on Journeys undertaken by me and the information available from literature.

In Nepal two species of *Pinus* are found:

Pinus wallichiana A. B. Jacks—Indigenous, with east-west distribution. Grows between altitude 2000 to 4000 m. In west Nepal, it is present in the extreme west between 2200 m to 3300 m altitude; in the valleys of Humula near Simikot at 2500 m; and on the side of Rara lake in Jumla at 3300 m. Grows in Bheri Zone. The highest altitude at which this species grows in Nepal is about 4800 m close to Kanjirobal Himal near Jumla. It is also present towards the north west of Pokhra. Grows as a dense forest on way to Kathmandu at Shivbhanjyang and Daman between altitude 2300 to 2650 m. In Kathmandu it is present at the lowest limit of 1500 m, it has been observed that *Pinus wallichiana* growing at Kathmandu bears a less developed membranous sheath on dwarf shoots or foliar spurs in comparison to those growing at higher altitudes where the plants develop scales on the spurs. Specimens collected are preserved in the Herbarium, M.S. College, Saharanpur. In the east it is present near Langtang valley and at Rolwaling near lontitude 86°E and in the eastern most part of Nepal particularly in areas like Namche, Lamche bazar, Topke and Walangchung between longitudes 86.8°E to 88°E.

Pinus roxburghii Sargent — Indigenous,

grows between 1000 to 25000 m. In west Nepal it is present towards north of Nepal-ganj and Dhangarhi between longitudes 80.8°E to 82°E. It is sparsely present in Dang district. It is rare between 83°E to 84.5°E. Some plants are present in Narayangarh area of Central Nepal. Forest of this species is also abundant in Kathmandu at 1500 m altitude. In east Nepal it is rare.

ASHOK K. BHARGAVA

DEPARTMENT OF BOTANY,
MAHARAJ SINGH COLLEGE,
SAHARANPUR, (U.P.),
March 8, 1977.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1976-77

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HONORARY SECRETARY'S REPORT FOR THE YEAR 1976

This report covers the activities of the Society in the 93rd year of its existence.

MEMBERSHIP

During the year 146 new members were enrolled. However, the number at the end of the year, particularly of ordinary members was less than that of the same period the previous year. We hope to stop this downward trend with more attention to reminders to members and by increasing activities likely to attract members to the Society and to retain them.

	1973	1974	1975	1796	1977
Ordinary Members	801	770	763	719	702

The numbers of other classes of members are given below:

	1973	1974	1975	1976	1977
Life Members	187	198	232	247	247
Student Members	9	16	20	19	20
Honorary Members	3	4	4	4	4
Forest Department Nominees	89	90	90	36	—

PUBLICATIONS

Our efforts to publish the Society's *Journal* in time have not been successful owing to various reasons. Four numbers were published during the year Vol. 71(3) (Sálim Ali Festchrift), Vol. 72(2), (3) and Vol. 73(1). With the April issue Vol. 73(1) for 1976 we have changed the printing format to 2-column printing and we hope to better utilise space and publish the considerable backlog of articles in hand. We are grateful to the Department of Science and Technology, Government of India, for special financial assistance.

The articles continued to cover a wide range of subjects with emphasis on the ecology, behaviour and taxonomy of Indian Fauna and the taxonomy and regional lists of Indian Flora.

Hornbill:

The inaugural issue of the Society's newsletter-cum-illustrated popular journal was published during the year with financial assistance from the Sálim Ali Conservation Fund. We hope the *Hornbill* will attract more members to the Society.

Books:

During the year the following sales were made:

	Sale	Balance Stock 31 December 1976
Book of Indian Birds	492	98
Book of Indian Animals	810	545
Snake Charts	32	854
Checklist of the Birds of Maharashtra	65	524
Glimpses of Nature in India	157	2780

The year saw the realisation of our plans to reprint our out-of-print books. Financial support from the Department of Science and Technology, Government of India was received for the reprinting of "Some Beautiful Indian Trees" and "Some Beautiful Indian Climbers and Shrubs". Work is in progress.

Financial support was also received from the Department of Science and Technology, Government of India for new publications, namely, "Encyclopaedia of Indian Natural History" and "A Century of Indian Natural History" to be released during 1983, the Centenary year of the Society and for printing and publishing the "Grasses of the Gir" by T. Hodd, being one of the scientific results of the Gir Project administered by the Society.

Work was started on the publication of the 2nd revised edition of the "Synopsis of the birds of India and Pakistan" by Dillon Ripley. Work was also commenced on the 10th edition of the perennially popular "Book of Indian Birds" by Sálim Ali.

Conservation

The Society continued to take an active part in the Conservation Movement in the country through its association with State and Central Wildlife Boards, and through its members on the International Union for Conservation of Nature and Natural Resources, the World Wildlife Fund, and the International Council for Bird Preservation.

Member's Activities

It has been possible to involve members in Bombay and elsewhere in field activities.

Bharatpur Nature Camp 15 *to* 31 *October*: Sixty members from all over India were given the opportunity of learning more about birds and bird watching. The group was led by Dr. Robert B. Grubh.

Bird Count: A monthly roadside count of birds in the Borivli National Park was organised with the assistance of members. The activity received financial assistance from the Sálim Ali/Loke Ornithological Research Fund. The activity is being continued.

Nature Walks: Nature Walks were organised in Borivli National Park for birdwatching and for a study of the vegetation. A large number of members participated.

Research and Field Studies

Sálim Ali/Loke Ornithological Research Fund: The Fund continued to support with fellowships, Mr. M. A. Reza Khan investigating the Ecology of the Black-and-Orange Flycatcher of South India, and Mr. Zacharias of Calicut University, Kerala, studying the Ecology and Biology of Babblers under the guidance of Dr. D. N. Mathew. A fellowship was awarded to Miss Priya Davidar to study the Ecology of Nectar-feeding Birds and their role in the Dissemination of Plant Parasites. The fund also extended support to the organisation of a monthly bird census at Borivli National Park.

Indian Council of Agricultural Research: Mr. Humayun Abdulali, assisted by a Scientist and a Research Assistant employed for the purpose, commenced an inquiry into the repercussions created by the commercialization of frogs legs in the Bombay area. The project is financed by the Indian Council of Agricultural Research.

Bird Migration Study: The data collected under the bird migration study project is being organised for computer analysis. Financial assistance has been received for the project from the Government of India.

Hingolgadh Bird Migration Study from 21-9-1976 *to* 8-10-1976: A fortnight's bird migration study camp was held at Hingolgadh at

Jasdan, Gujarat, for training local students in bird study.

University Department: Mr. V. S. Vijayan was awarded the degree of Ph.D. in field Ornithology by the University of Bombay for his thesis on the "Ecology of Sympatric Bulbuls". Dr. Sálim Ali was the Guiding teacher. Mr. George Kuruvilla was awarded the M.Sc. degree by the University of Bombay for his thesis on the "Ecology of the Bonnet Macaque". His Guiding Teacher was Mr. J. C. Daniel.

Melghat Bird Survey from 12-2-1976 *to* 5-3-1976: Dr. Sálim Ali, accompanied by Dr. Dillon Rilpey, Secretary, Smithsonian Institution, and members of the Society's staff, surveyed areas in Maharashtra in search of the rare Blewitt's Owl.

Though not successful in their main enquiry the survey party brought several interesting additions to the Research Collection. Mr. S. A. Hussain was subsequently deputed to Mandvi in Gujarat for the same purpose but the owl was not found.

Sriharikota Island from 19-1-1976 *to* 31-1-1976: At the instance of the Indian Space Research Organization the bird life of Sriharikota Island was surveyed by Dr. Robert B. Grubh and a report was prepared.

Borivli National Park: With the active assistance of its local members and organisations the Society was able to convince Government that it would be highly detrimental to construct a luxury Tourist complex within the Park. The Chief Minister and his colleagues in Government deserve the thanks of all conservationists for deciding to cancel the project.

Crocodile Specialist Group Meeting on 5-12 *April* 1976: The Curator attended the meeting of the group held at Maningrida, Northern Territory, Australia. A report was circulated to concerned authorities in India.

Crocodile Status Survey from 8 *November to* 15 *November* 1976: On behalf of the Government of Maharashtra, Mr. J. C. Daniel, Curator, surveyed Crocodile habitats in the State for selecting an area for captive breeding. A report was submitted to the Government.

Ladakh Survey from 11 *June to* 11 *August* 1976: Dr. Sálim Ali with the assistance of the Society's staff and members surveyed the status of the Black-necked Crane and wildlife in general in Ladakh. A report was submitted to the Government of India. The survey was sponsored and financed by World Wildlife Fund-India.

Nilgiri Langur Study: The Society sponsored the study of the ecology of the Langur in Kalakkad Forests, Tamil Nadu, by Dr. John Oates of the Rockefeller University.

Lammasinghi Birds from 24 *December* 1976 *to* 2 *February* 1977: The study of the bird population of Lammasinghi Eastern Ghats by Trevor Price, a Leverhulme fellow (U.K.) was sponsored.

Field Work Awards

Charles McCann Field Work Fund: A grant was made (Rs. 360) on 29-9-1976 to Miss Anuradha of Bangalore University to study the ecology of the little-known Opilionid arachnids, commonly known as Harvestmen. Mr. George Kuruvilla was given assistance on 29-4-1976, 27-6-1976 and 28-6-1976 (Total Rs. 600) for his study of the ecology of the Bonnet Macaque.

Charles McCann Field Work Fund: A grant was made (Rs. 194.80) to Mr. S. M. Ketkar on 6-4-1976 to study flamingo feeding habits. Assistance was given (Rs. 1000) to Mr. Humayun Abdulali from 12-3-1976 to 25-4-1976 for a field survey of the Nicobars.

Donations

	Rs.	
Mr. R. Shroff	2000	for 16 mm Projector
Mr. G. V. Bedekar	1000	
M/s Advani Oerlikon	250	
Mr. Nazir Latif	500	for Miscellaneous expenses
Dr. (Miss) Hamida Saiduzzafar		Rs. 5000 for Sálim Ali/Loke Ornithological Research Fund
Jt. Director, Rajendra Prasad Institute	50	for Charles McCann Fund
Dr. Sálim Ali	2000	for general expenses
Dr. Sálim Ali	1000	for Field Work Fund
Dr. Sálim Ali	2000	for Sálim Ali/Loke Ornithological Research Fund
Dr. Sálim Ali	1000	for printing plates of Bird Book
Mr. G. S. Ranganathan	100	for Charles McCann Fund
Mr. S. Chaudhuri	600	for Charles McCann Fund
Sir Dorabjee Tata Trust	3000	for Field Work Fund
Pirojsha Godrej Foundation	10000	for Field Work Fund

Meetings

January, 15 & 16: *Film Show*: "Serengeti shall not Die".

February, 10: *Slides show*: "Monsoon 1974-75" by the members of the Photographic Cell.

February, 12 & 13: *Film Show*: "Francois Le Rhinoceros".

July, 23: *Film Show*: "The White Stork".

August, 10: *Talk*: "Social Behaviour of Monkeys and Apes" by Dr. Y. S. Sugiyama.

September, 24: *Film Show*: "The Desert —An Arena of Life", "Our Home is the Earth", "An Auroch's Preserve."

September, 29: *Talk*: On the BNHS/WWF Ladakh Expedition, 1976 by Team Members: Dr. Sálim Ali, Mr. S. A. Hussain and Mr. Prakash Gole.

October, 27: *Talk*: On "Wildlife in India" by E. Hanumantha Rao.

November, 13: *Talk*: On "Wildlife in Tanzania" by H. E. Dr. Solomon Ole Saibull.

November, 26: *Talk*: "Life of the Spotted Deer" by Prof. Madhav Gadgil.

Reference Collection

During the year the following 448 specimens were added:

Mammals	18
Birds	124
Reptiles	128
Amphibians	78
Insects	100

Important additions are:

Birds: *Spilornis cheela minimus* — Coll: H. Abdulali

Coturnix t. trinkutensis Coll: H. Abdulali

Reptiles: *Cyrtodactylus triedrus* — R. Whitaker

Phrynocephalus reticulatus — Ladakh Survey

Argyrogena fasciolatus — Azeem Shaik

Nature Education Scheme

Eight field trips were arranged to Borivli National Park for students and trainee teachers. 22 schools were visited personally by Mrs. Shailaja R. Grubh, Nature Education Organiser, during the year and 450 schools were contacted from time to time through circulars.

Guidance was given to 8 schools in preparing projects on different aspects of nature. 2 radio programmes on Nature Education were given during the year. 14 schools were taken to Prince of Wales Museum, 10 to Taraporewala Aquarium and 13 to Victoria Garden. Film shows were arranged in 2 schools and in one training college. During Wild Life Week a talk ("On our wild life" illustrated with slides) was given to the forest trainee guards Shahpur and an essay competition was held for students of 8th to 11th standard. We are grateful to Mr. Menezes, a member of the Society who conducted field trips to Borivli National Park during the Nature Education Organiser's annual leave.

Library

During the year 256 books were added to the Library, of which 11 were purchased, 229 donated (169 by the trustees of the late Mrs. Usha Ganguli and 36 by Dr. Sálim Ali and the rest by other members) and 16 received as review copies for the Journal. The total number of books and bound periodicals in the library is over 9000 and includes many rare and out-of-print volumes on Indian natural history.

Revenue and Accounts

The financial situation of the Society continued to be strained on account of losses in previous year, however, 1976 showed a small surplus.

Staff

The Committee wishes to record its appreciation of the willing co-operation of the staff in the activities of the Society.

REGISTERED NO. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY
THE BOMBAY PUBLIC TRUST ACT, 1950
Schedule VIII [vide Rule 17(1)]

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER* 1976

FUNDS AND LIABILITIES

Trust Funds or Corpus:		
Life Membership fund:		
Balance as per last Balance Sheet	96,647.61	
Add: Amount received during the year	5,186.42	1,01,834.03
Fixed Assets Fund:		
Balance as per last Balance Sheet	99,287.76	
Add: Value of fixed assets purchased during the year from Government grant	—	
Less: Transferred from Income & Expenditure account on account of depreciation for the year	14,723.82	84,563.94
General Reserve Fund:		
Balance as per last Balance Sheet		34,015.40
Building Fund:		
Balance as per last Balance Sheet		9,244.68
Publication Fund:		
Balance as per last Balance Sheet	35,716.00	
Add: Sale proceeds of Glimpses of Nature booklets published under WWF/Volkart Foundation grant	926.25	36,642.25
Carried forward		2,66,300.30

ASSETS

Immovable Properties:		Nil
Investments: (At Appropriated Value)		
50, 8% Convertible Bonds each of Rs. 100/- of Ahmedabad Manufacturing & Calico Printing Co. Ltd. fully paid (Market value Rs. 3,500/-)	2,130.20	
202, 8% Redeemable Bonds each of Rs. 116/- of Ahmedabad Manufacturing & Calico Printing Co. Ltd. fully paid (Market value Rs. 16,362/-)	9,982.95	
Government Securities: (At cost)		
3% Conversion Loan 1946/86 of the face value of Rs. 25,000/- (Market value Rs. 15,000/-)	25,000.00	
$5\frac{1}{2}$% Government of India Loan 2000 of the face value of Rs. 2,000/- (Market value Rs. 1,811/-)	2,000.00	39,113.15
Deposit with:		
M/s. Indian Dyestuff Industries Ltd., Bombay (against Dr. Sálim Ali-Loke Wan Tho Ornithological Research Fund)		1,25,000.00
Motor Cars, Motor Cycle & Auto Cycle:		
Balance as per last Balance Sheet	29,360.30	
Less: depreciation during the year	5,872.04	23,488.26
Carried forward		1,87,601.41

FUNDS AND LIABILITIES

Brought forward		2,66,300.30
Other Earmarked Funds:		
(As per Schedule 'A')		4,48,018.82
Provision for Capital Losses:		
Balance as per last Balance Sheet		4,528.38
Provision for Depreciation on Investment:		
Balance as per last Balance Sheet		9,266.10
Liabilities:		
For expenses	78,144.26	
For Advance Subscriptions	2,988.63	
For Sundry credit balances	25,470.43	
		1,06,603.32
Carried forward		8,34,716.92

ASSETS

Brought forward		1,87,601.41
Furniture, Fixture & Equipments:		
Balance as per last Balance Sheet	69,827.46	
Add: additions during the year	3,947.38	
	73,774.84	
Less: depreciation during the year	8,851.78	64,923.06
Loans: (Unsecured considered good)		365.00
Advances: (Unsecured considered good)		
To employees	1,034.58	
To others	2,004.48	3,039.06
Stocks: Publications (as per inventory taken and certified by the Curator)	11,313.45	
Work in process (Book of Indian Birds by Dr. Sálim Ali, 10th edition)	2,824.17	14,137.62
Income Outstanding:		
Interest accrued	19,993.44	
Supplies & Services	83,533.85	
Grant Govt. of India, for Journal exps.	20,000.00	1,23,527.29
Cash and Bank Balances:		
A) *In current account with*:		
1. Grindlays Bank Ltd., Mahatma Gandhi Road, Bombay	48,919.89	
2. Grindlays Bank Ltd., London (£ 1,403.36) (converted at Rs. 15.33 = £ 1)	21,513.50	
3. Chartered Bank, Bombay	9,050.44	
B) *In savings account with*: Grindlays Bank Ltd., M.G. Road, Bombay	23,266.49	
Carried forward	1,02,750.32	3,93,593.44

FUNDS AND LIABILITIES		ASSETS		
Brought forward	8,34,716.92	Brought forward		3,93,593.44
		Cash and Bank Balances: (contd.). B/f.	1,02,750.32	
		C) *In fixed deposit with*:		
		1. Bank of India, Bombay (consisting of Rs. 36,000/- for Dr. Sálim Ali-Loke Wan Tho Ornithological Research fund & Rs. 3,000/- for Col. Burton's Nature Conservation fund)	39,000.00	
		2. Chartered Bank, Bombay (including Rs. 18,000/- of Charles McCann Vertebrate Zoology field work fund & Rs. 49,000/- for Dr. Sálim Ali/Loke-Wan Tho Ornithological Research Fund	67,400.00	
		3. Grindlays Bank Ltd., Bombay (including Rs. 10,000/- of Dr. Sálim Ali-Loke Wan Tho Ornithological Research fund Rs. 20,000/- for Pirojsha Godrej Foundation fund	1,70,000.00	
				3,79,150.32
		Income and Expenditure Account:		
		Balance as per last Balance Sheet	66,525.89	
		Less: Excess of Income over expenditure as per Income & Expenditure account	4,552.73	61,973.16
TOTAL	8,34,716.92	TOTAL		8,34,716.92

Sd/- SALIM ALI,
President,
Bombay Natural History Society.

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society.

Sd/- C. V. KULKARNI,
Honorary Treasurer,
Bombay Natural History Society.

As per our report of even date
Sd/- HABIB & Co.,
Chartered Accountants

BOMBAY, *3rd October*, 1977.

SCHEDULE 'A'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF THE BALANCE SHEET AS AT 31 *DECEMBER*, 1976

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ Refunded* during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December 1976 (5 minus 8)* (9)
(1) Field Work Fund (Sir Dorabjee Tata Trust)	225.14	3,000.00	–	3,225.14	1,056.00	–	1,056.00	2,169.14
(2) Staff Welfare Fund	2,020.69	–	–	2,020.69	–	–	–	2,020.69
(3) Dr. Sálim Ali-Loke Wan Tho Ornithological Research Fund	2,13,136.52	7,000.00	–	2,20,136.52	–	–	–	2,20,136.52
(4) Col-Burton's Nature conservation fund	3,575.34	300.00 (interest)	–	3,875.34	–	–	–	3,875.34
(5) Charles McCann Vertebrate Zoology field work fund	18,627.00	2,633.10 (including Interest Rs.1800/–)	–	21,260.10	1,394.16	–	1,394.16	19,865.94
(6) Grant Seth Purushottamdas Thakoredas & Divaliba Charitable Trust for the publication of Shri M. Krishnan's India's wild life (Ecological survey of India)	5,991.54	–	–	5,991.54	162.25	–	162.25	5,829·29
(7) Grant from His Majesty King of Bhutan for the publication of "Birds of Bhutan" by Dr. Sálim Ali	5,813.39	–	–	5,813.39	–	–	–	5,813.39
(8) Grant from World Wild Life Fund for the publication of booklet on conservation	3,024.58	–	–	3,024.58	–	–	–	3,024.58
(9) Grant from Fauna Preservation Society, London for Leopard Survey project	44.46	–	–	44.46	44.46	–	44.46	–
(10) Scholarship fund under Dr. Sálim Ali-Loke Wantho Ornithological Research fund Investments	11,610.52	22,037.00 (Interest)	–	33,647.52	27,190.31	–	27,190.31	6,457.21
Carried forward	2,64,069.18	34,970,10	–	2,99,039.28	29,847.18	–	29,847.18	2,69,192.10

Name of the Fund/Grant (1)	Balance as per last Balance Sheet (2)	Additions/ Amounts received during the year (3)	Transfers from other Funds (4)	Total of columns 2, 3, & 4 (5)	Spent/ Refunded* during the year (6)	Transfers to other Funds (7)	Total of columns 6 & 7 (8)	Balance as at 31st December 1976 (5 minus 8) (9)
Brought forward	2,64,069.18	34,970.10	–	2,99,039.28	29,847.18	–	29,847.18	2,69,192.10
(11) Dr. Sálim Ali's 75th Birth day fund	12,595.76	–	–	12,595.76	–	12,595.76	12,595.76	–
(12) Grant from Govt. of India, Department of Science & Technology for Plan Expenditure 1976-77	–	50,000.00	–	50,000.00	5,030.70	–	5,030.70	44,969.30
(13) Grant from Govt. of India, Department of Science & Technology for publication under Plan expenditure for 1975-76 contd. 1976-77	36,674.26	–	–	36,674.26	1,035.00	–	1,035.00	35,639.26
(14) Grant from Govt. of India, Department of Science & Technology for the back log of Journal printing exps. 1976-77	–	28,000.00	–	28,000.00	6,820.00	–	6,820.00	21,180.00
(15) Grant from Govt. of India, Department of Science & Technology for Encyclopedia of Natural History 1976-77	–	22,000.00	–	22,000.00	–	–	–	22,000.00
(16) Grant from Bodega Bay Institute of Pollution Ecology for DDT pollution	1,332.36	–	–	1,332.36	–	–	–	1,332.36
(17) Director of Archives, Tamil-Nadu for Pudukkottai Bird Survey	15.30	–	–	15.30	–	–	–	15.30
(18) Commissioner of Archives, & Historical Research Tamil Nadu for Nilgiri Dist., Gazetteer Survey of Avifauna	–	5,000.00	–	5,000.00	–	–	–	5,000.00
(19) Indian space Research Organisation, Sriharikotta for Bird survey	–	2,227.00	–	2,227.00	–	–	–	2,227.00
Carried forward	3,14,686.86	1,42,197.10	–	4,56,883.96	42,732.88	12,595.76	55,328.64	4,01,555.32

SCHEDULE 'A' (contd.)

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ Refunded* during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December 1976 (5 minus 8)* (9)
Brought forward	3,14,686.86	1,42,197.10	–	4,56,883.96	42,732,88	12,595.76	55,328.64	4,01,555.32
(20) The Pirojsha Godrej Foundation Fund	10,000.00	10,000.00	–	20,000.00	–	–	–	20,000.00
(21) Grant from Indian, Council of Agricultural Research for determination of ecological disturbances in agricultural and adjoining lands caused by removal of *Rana tigrina* and *Rana hexadactyla* for export	–	18,200.00	–	18,200.00	11,283.52	–	11,283.52	6,916.48
(22) Field work fund under Pirojsha Godrej Foundation fund investment	–	1,166.66 (Interest)	–	1,166.66	550.00	–	550·00	616.66
(23) Projector Fund received from Members	–	3,250.00	–	3,250.00	–	–	–	3,250.00
(24) *Grants from Government of Maharashtra*:								
1. *Grant for* 1975-76:								
(a) For Establishment expenses	16,992.53	–	–	16,992.53	15,431.76) 701.01*)	859.76	16,992.53	–
(b) For Building Maintenance	326.38	–	859.76	1,186.14	1,186.14	–	1,186.14	–
2. *Grant for* 1976-77: For establishment and Building Maintenance	–	71,688.00	–	71,688.00	56,007.64	–	56,007.64	15,680.36
Total	3,42,005.77	2,46,501.76	859.76	5,89,367.29	1,27,892.95	859.76	141,348.47	4,48,018.82

* The relevant amount being unspent have been refunded to the Government authorities.

BOMBAY, *3rd October*, 1977.

Sd/- HABIB & Co.,
Chartered Accountants

BOMBAY NATURAL HISTORY SOCIETY
THE BOMBAY PUBLIC TRUST ACT, 1950
SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER*, 1976

EXPENDITURE		
To Expenses in respect of Projects:		
Rates, taxes and cesses	Nil	
Repairs & Maintenance	470.31	
Salaries	Nil	
Depreciation (by way of provision or adjusted)	Nil	470.31
,, *Building Maintenance Expenses*:		
(As per contra)		
Met out of the Maharashtra Govt. grant		
for 1975-76	1,186.14	
for 1976-77	9,000.00	10,186.14
,, *Establishment Expenses*:		
Salaries including D.A. from Govt. of Maharashtra grant (as per contra)		
for 1975-76	15,431.76	
for 1976-77	47,007.64	
Salaries including D.A. (other than above)	88,731.25	
Society's contribution to staff provident fund	4,890.16	
Payment for ex-gratia payment to retired employees	2,300.00	
Postages	3,930.82	
Printing and stationery	7,175.06	
Advertisement	133.80	
Carried forward	1,69,600.49	10,656.45

INCOME			
By Rent (Accrued & Realised)			Nil
,, *Interest* (Accrued & Realised)			
On Securities	3,134.56		
Less: Income Tax deducted at source	523.00	2,611.56	
On fixed deposits	35,673.60		
Less: Income Tax deducted at source	1,438.00	34,235.60	36,847.16
,, *Donations*:			
In cash		9,637.00	
In cash for field work		1,000.00	
In cash for Book of Indian Birds		1,000.00	
In cash for Hornbill Newsletter		1,000.00	12,637.00
,, *Towards Specific Funds*:			
Charles McCann Vertebrate Zoology field work fund		750.00	
Sir Dorabjee Tata field work fund		3,000.00	
Pirojsha Godrej Foundation fund		10,000.00	
Projector fund		3,250.00	
Sálim Ali-Loke Wan Tho Ornithological Research fund		7,000.00	24,000.00
Carried forward			73,484.16

Expenditure		
Brought forward		10,656.45
Establishment Expenses: (contd.) B/f.	1,69,600.49	
Telephone charges	4,864.65	
Bank charges	835.35	
Meeting exps. including talks, films shows and Annual General Meeting expenses	1,837.15	
Conveyance & travelling expenses (Local)	583.38	
Motor car expenses	641.90	1,78,362.92
,, *Audit Fees*:		1,000.00
,, *Amounts Written off*:		
(a) Bad debts	448.94	
(b) Loan scholarships	—	
(c) Irrecoverable rent	—	
(d) Loss on exchange due to devaluation of sterling pound	3,132.66	
		3,581.60
,, *Miscellaneous Expenses*:		
General charges	847.99	
Insurance premium	217.95	
Repairs to furniture & equipment	603.04	
Printing of Society's prospectus	850.00	
Printing of proposed new rules	450.00	2,968.98
,, *Depreciation*:		
On furniture and equipment	8,851.78	
On Motor cars, Motor cycle & Auto cycle	5,872.04	14,723.82
,, *Amounts Transferred to Reserve or Specific Funds*: (as per contra)		
1. Grants transferred to relevant funds	1,97,115.00	
2. Donations towards specific funds transferred to relevant accounts in the balance sheet	24,000.00	
Carried forward	2,21,115.00	2,11,293.77

Income		
Brought forward		73,484.16
,, *Grants*:		
(a) *Government of Maharashtra*:		
1. for 1976-77 Establishment and Building maintenance expenses	71,688.00	
2. for 1976-77 Educational activity	4,000.00	
(b) *Government of India*:		
Department of Science & Technology		
1. for 1976-77 Journal printing exps.	20,000.00	
2. for 1976-77 Plan expenditure (bird banding data analysis)	50,000.00	
3. for 1976-77 back log of Journal printing expenses	28,000.00	
4. for 1976-77 Encyclopaedia of Indian Natural History	22,000.00	
(c) Indian National Science Academy for 1976-77 Journal printing exps.	3,000.00	
(d) Govt. of Tamil Nadu for Nilgiri Dist. Gazetter Survey	5,000.00	
(e) Indian space Research Organisation for bird survey in Sriharikota	2,227.00	
Carried forward	2,05,915.00	73,484.16

Expenditure		
Brought forward		2,11,293.77
Amount Transferred to Reserve or Specific Funds: (contd.) B/f.	2,21,115.00	
3. Sale proceeds transferred to publication fund account (Glimpses of Nature booklet)	926.25	
4. Sale proceeds transferred to Charles McCann vertebrate zoology field work fund	83.10	
5. Interest on fixed deposits transferred to respective funds	25,303.66	2,47,428.01
„ *Expenses on Objects of the Trust*:		
(A) *Educational*:		
from respective funds (as per contra)		
(1) Scholarships for field work (out of field work fund Sir Dorabjee Tata Trust)	1,056.00	
(2) Expenses on Leopard survey project (out of grant Fauna Preservation Society, London)	44.46	
(3) Expenses towards research scholarships and other expenses on Ornithological Research (out of scholarship fund under Dr. Sálim Ali-Loke Wan Tho Ornithological Research Fund Investment)	27,190.31	
(4) Expenses on publication of Shri M. Krishnan's book on India's Wild life (out of grant from Shri Purushottamdas Thakoredas & Divaliba Charitable Trust)	162.25	
Carried forward	28,453.02	4,58,721.78

Income		
Brought forward		73,484.16
„ *Grants*: (contd.) B/f.	2,05,915.00	
(f) Indian Council of Agricultural Research for 1976-77 for Frog project	18,200.00	2,24,115.00
„ *Income from Subscription & Entrance Fees*:		
Membership subscriptions	28,978.43	
Student Membership subscriptions	360.00	
Corporate Membership subscriptions	22,328.70	
Subscription to Journal (non members)	11,819.66	
Entrance fees	3,275.00	66,761.79
„ *Income from Publications*:		
Journal sales	1,602.51	
Glimpses of Nature booklets	926.25	
Checklist of Birds of Maharashtra	83.10	2,611.86
„ *Surplus on sale of Books*:		
Book of Indian Birds	8,347.90	
Book of Indian Animals	15,022.20	
Identification of Poisonous snake charts	165.00	
Other publications	2,861.85	
Nature calendars	34,836.70	
	61,233.65	
Less: Packing & forwarding chs.	328.39	60,905.26
Carried forward		4,27,818.07

EXPENDITURE			
Brought forward			4,58,721.78
Expenses on Object of the Trust (contd.) B/f.		28,453.02	
(5) Expenses on field staff salaries, bird data analysing study, bird migration study, and study collection, (out of grant from Govt. of India, Department of Science & Technology for plan expenditure)		5,030.70	
(6) Expenses on publication (out of grant Govt. of India, Department of Science and Technology 1975-76)		1,035.00	
(7) Expenses on Indexes of back issues of Journal printing met out of grant Govt. of India, Department of Science & Technology 1976-77		6,820.00	
(8) Expenses on field studies (met out of Charles McCann vertebrate Zoology field work fund)		1,394.16	
(9) Expenses towards Research scholarships met out if interest on Pirojsha Godrej Foundation fund		550.00	
(10) Expenses on Frog project (met out of the grant from Indian Council of Agricultural Research)		11,283.52	
(B) Journal expenses		60,505.44	
(C) Field study programme and other field study trips		3,586.54	
(D) Expenses on field staff salaries, study collections, Bird migration study etc. as on 31-3-1976.		6,223.75	
(E) *Library Account*:			
Subscriptions to other Societies	1,933.84		
Purchase of books	409.40		
Other Library expenses	18.20		
		2,361.44	
Carried forward		1,27,243.57	4,58,721.78

INCOME		
Brought forward		4,27,878.07
„ *Miscellaneous Income*:		
Library fines	44.70	
Fees for the use of Society's transparencies	1,050.00	
Other receipts	1,251.58	2,346.28
„ *Administrative Fees*:		
For handling various project funds during the year debited to respective funds		7,948.38
„ *Transfers* (to specific funds)		
Depreciation on fixed assets transferred to fixed assets fund (as per contra)	14,723.82	
Expenditure on establishment and Building maintenance transferred to Govt. of Maharashtra grant (as per contra)	72,625.54	
Expenditure on other specific objects transferred to relevant funds (as per contra)	54,566.40	
Transfer from Reserve or Specific Funds:		
Amount transferred from Dr. Sálim Ali's 75th Birth day fund	12,595.76	1,54,511.52
Carried forward		5,92,684.25

Expenditure			Income	
Brought forward		4,58,721.78	Brought forward	5,92,684.25
B/f.	1,27,243.57			
(F) Maintenance of Reference collections	2,166.17	1,29,409.74		
Excess of Income over expenditure transferred to Balance Sheet		4,552.73		
Total		5,92,684.25	Total	5,92,684.25

Sd/- SALIM ALI,
President.

Sd/- A. N. D. NANAVATI,
Honorary Secretary.
Sd/- C. V. KULKARNI,
Honorary Treasurer.

As per our report of even date
Sd/- HABIB & COMPANY,
Chartered Accountants.

BOMBAY, *3rd October*, 1977.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31 *December*, 1976

RECEIPTS		
To Balance as at 1*st January,* 1976:		
With Grindlays Bank Ltd., Bombay on current account	9,877.38	
With Nature Education Organiser	200.00	10,077.38
,, *Grant from Government of Maharashtra*:		
For 1976-77		10,046.00
Sales of Nature Study Booklets		224.43
Total		20,347.81

PAYMENTS		
By Refund of balance due to Bombay Natural History Society as on 1st January, 1976		19.68
,, Refund of Unspent amount of Grant, Govt. of Maharashtra for 1975-76		124.47
,, Salary Nature Education Organiser		7,989.30
,, Printing and Staltionery		427.50
,, General charges		1,072.08
,, Postages		146.65
,, *Balance as at* 31*st December,* 1976:		
1. With Bombay Natural History Society	79.40	
2. With Grindlays Bank Ltd., Bombay on current account	10,288.73	
3. Cash on hand with Nature Education Organiser	200.00	10,568.13
Total		20,347.81

Sd/- SALIM ALI,
President.

Sd/- A. N. D. NANAVATI,
Honorary Secretary.
Sd/- C. V. KULKARNI,
Honorary Treasurer.

As per our Report of even Date
Sd/- HABIB & COMPANY,
Chartered Accountants.

BOMBAY, 3*rd October*, 1977.

MINUTES OF THE ANNUAL GENERAL MEETING HELD ON FRIDAY 30 JUNE 1978 AT 6.30 P.M. AT HORNBILL HOUSE, SHAHID BHAGAT SINGH ROAD, BOMBAY, WITH MR. R. E. HAWKINS IN THE CHAIR

The following twenty-five members were present:

Mr. Humayun Abdulali
Mr. Salman Abdulali
Mr. Idrees Ali
Dr. Sálim Ali
Mr. Shahid Ali
Dr. S. R. Amladi
Mr. G. V. Bedekar
Mr. Narayan Chhatbar
Dr. P. J. Deoras
Mr. H. K. Divekar
Mr. D. N. Goenka
Mr. R. E. Hawkins
Mr. A. K. Joshee
Dr. C. V. Kulkarni
Mr. Nazir Latif
Mr. Bansi Mehta
Mr. Chandragupta Bhogilal Mehta
Dr. A. N. D. Nanavati
Mr. S. R. Nayak
Mr. P. V. Panat
Mr. D. J. Panday
Mr. V. K. Paralkar
Mr. K. K. Vajifdar
Mr. I. G. Valles
Mrs. D. Variava

The President requested Mr. R. E. Hawkins, the senior Vice-President of the Society to preside.

The Chairman requested the Honorary Secretary to present his Report for the year ended 31st December 1976.

(1) The Honorary Secretary explained that the delay in presenting the accounts for 1976 was due to the need to have the Rules adopted at the Annual General Meeting held on 22-23 November 1976 approved by the Charity Commissioner. His approval was delayed by the Government of Maharashtra servants' strike in 1977 and had only recently been received. The Honorary Secretary advised that as the cyclostyled report was available to members he would not read it, but would give some account of the activities of the Society in the year 1977.

The year had seen the successful launching of the Society's newsletter *Hornbill*; work had begun on the centenary *Encyclopaedia of Indian Natural History; Some Beautiful Indian Trees* had been reprinted; the second edition of the *Synopsis of the Birds of India and Pakistan* was being printed; and the Festchrift in honour of Dr. Sálim Ali was soon to be published in book form by the Oxford University Press under the title *A Bundle of Feathers*.

The Honorary Secretary also referred to the activities of the Society in the field of nature conservation and research and assured the meeting that a full report would be available in the Society's annual report for the year 1977.

The Chairman then invited comments on the report.

Dr. P. J. Deoras inquired about the nature of the bird count at Borivli National Park, and how data on the food of *Rana tigerina* was being collected under the ICAR scheme.

The Curator explained the bird count and the Principal Investigator of the ICAR scheme, Mr. Humayun Abdulali, explained the methods of collection of frogs stomachs and their examination.

Dr. Deoras asked the total number of birds ringed by the Society and the total number of recoveries or ringed birds. The Curator stated

that approximately over 2 lakhs of birds had been ringed and that he would give a written reply indicating the precise number ringed and the number of birds recovered.

Mr. Humayun Abdulali complained that in spite of several requests to the Committee, and even as a member of the Executive Commitee, he had not been able to obtain a satisfactory explanation of the computer programme and also expressed the opinion that recovery of less than 2000 specimens of a species was of little value. The Chairman suggested to Mr. Abdulali that he should contact the Tata Institute of Fundamental Research, the collaborators on the computer study programme for explanatory details.

Dr. P. J. Deoras wished to know what action the Society planned to take to prevent construction of the Disneyland and the Ropeway in the Borivli National Park. The Curator replied that these projects were at the edge of the Park in the Krishnagiri Upavan, but that he was hopeful that no further building would be undertaken in the Park itself.

Dr. Deoras wished to be advised of the areas selected for Crocodile breeding programme in the State. The Curator replied that he had suggested the Tadoba National Park as one of the sites. Mr. H. K. Divekar stated that he had visited several areas in Chandrapur district which would be suitable for Crocodile preservation, and advised that he would discuss the matter further with the Curator.

The annual report was then approved.

(2) The Chairman called upon the Honorary Treasurer to present the Balance Sheet and Statement of Accounts.

Mr. Humayun Abdulali queried the necessity for showing the market value of investments in the Balance Sheet. The Honorary Treasurer advised that this is the procedure followed by the auditors to show to the members actual value as on the date of the preparation of the Balance Sheet as against the marked value of the investment.

Dr. Deoras wished to have information on the nature of the Staff Welfare Fund. The Honorary Treasurer advised that the Staff Welfare Fund was made up of donations received specifically for the purpose from members of the Society and was being utilized for staff benefits such as short-term loans.

Dr. Deoras wanted to know the purpose for which the grant of the Government of Bhutan (Item 7, Schedule 'A') was received by the Society. The Honorary Treasurer advised that it was for secretarial and other assistance to Dr. Sálim Ali for the preparation of the manuscript and that the expenditure under this head would be shown in the accounts for the year 1977.

Three suggestions for improving the comprehensibility of the Annual Acounts were made by Messrs Abdulali and Dr. Deoras, namely: (1) that the pages be numbered in a single sequence instead of as in the accounts for 1976 Balance Sheet 1-3, Income & Expenditure account 1-4, Schedule A 1-3 and Nature Education Scheme unnumbered; (2) the grants from the Government of Maharashtra for (a) staff and maintenance of the Reference Collections and (b) maintenance of Hornbill House be so described; and (3) that in Schedule A the purpose of a grant should be indicated more precisely. For example, in the 1976 accounts, item 12, the narration 'for Plan Expenditure 1976-77' should specify the object. The Honorary Treasurer undertook to take these suggestions into consideration when preparing the accounts for 1977.

Dr. Deoras asked a question referring to a letter addressed by the auditors to the Honorary Secretary and Mr. Bedekar pointed out

that references to papers which were not before the meeting should be avoided.

The Balance Sheet and Statement of Accounts were then approved.

(3) Messrs Habib & Co. were re-appointed auditors, their remuneration to remain the same (Rs. 1,000).

(4) The Chairman advised that as there had been no nominations from members, the 12 persons nominated by the out-going Executive Committee were deemed to have been elected. Being elected for two years, they would continue till the Annual General Meeting to consider the accounts and annual report for the year 1978, which would probably be held in late 1979.

President

Dr. Sálim Ali, D.Sc., F.N.A.

Vice-Presidents

Mr. R. E. Hawkins
Mr. G. V. Bedekar, I.C.S. (Retd.)
Mr. D. J. Panday
Ex-Officio

EXECUTIVE COMMITTEE

Mr. H. Abdulali
Dr. S. R Amladi, M.D.
Prof. P. V. Bole
Mr. Divyabhanusinh Chawda
Dr. B. Dasgupta
Mr. H. K. Divekar
Dr. C. V. Kulkarni M.Sc., Ph.D. (*Hon. Treasurer*)
Mr. Nazir Latif
Mr. Bansi Mehta
Dr. A. N. D. Nanavati (*Hon. Secretary*)
Mr. M. S. Srinivasan
Mrs. Dilnavaz Variava
Secretary, Dept. of Science & Technology, Government of India.

ADVISORY COMMITTEE

Mr. H. G. Acharya	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Dr. B. Biswas	*Calcutta*
Mr. S. Chaudhuri	*New Delhi*
Dr. Chintaman Deshmukh, I.C.S. (Retd.)	*Hyderabad*
Mr. Zafar Futehally	*Bangalore*
Mr. N. D. Jayal	*New Delhi*
Mr. Shivrajkumar Khachar	*Jasdan*
Mr. M. Krishnan	*Madras*
Mr. Duleep Matthai	*New Delhi*

The Chairman also stated that there would be another Annual General Meeting, probably in October 1978, to consider the Annual Report and Accounts for the year 1977. Before this meeting, the *ex-officio* members for the year 1977 having served their term would resign and new *ex-officio* members, namely the President and not more than three Vice-Presidents would be appointed by the Executive Committee.

The Agenda having been completed, the Chairman closed the meeting at 7.30 p.m.

The meeting terminated with a vote of thanks to the Chair.

ERRATA

Volume 73(1): April 1976

Miscellaneous Note 5

The Dugong *Dugong dugon* (Sirenia) at Bahrain, Persian (Arabian) Gulf
On page 212, right column, lines 3, 4, and 7
For Ras al Bahr
read Ras al Barr.

On page 212, right column
The format of the Table should be as under:

SKULLS OF *D. dugon* FOUND AT BAHRAIN

14 Apr 1969	♂	E. coast, near Askar; a skull from the remains of an animal dead about 3 months.
27 Apr 1969	♂	Ras al Barr; an old skull.
1969	o?	Ras al Barr; an old skull.
29 Apr 1970	♀	E. coast, near Durr. Skull from a carcase, length *c.* 7 ft. reported dead 22 February 1970.
29 Apr 1970	♂	E. coast, near Durr. With the ♀ above; length 9-10 ft.
22 Feb 1970	o?	Ras al Barr. An old skull.
10 Feb 1971	♀	E. coast, near Ras al Qarain. Whole head [in deep freeze in the BM (NH)] from a freshly dead, fully fed animal, length 83 inches.

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Review No. 2

On page 199, left column, first para, line 8
For 18 and 19 centuries
read 1894 and 1950.

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